NOTICE TO
FLOOD INSURANCE STUDY USERS

Individual components of this Flood Insurance Study (i.e., text, tables, profiles, and maps) are all subject to revision as additional data become available. Because revised components may be issued separately, study users should consult the community map repository for those components that are currently effective.

In cases where this Flood Insurance Study and any components thereof warrant revision, a Revisions Description section may be incorporated into this text. When applicable, study users should refer to the Revisions Description to obtain pertinent data and information concerning revisions.

BEST COPY AVAILABLE

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
1.1	Purpose of Study	1
1.2	Coordination	1
1.3	Authority and Acknowledgments	1
2.0	AREA STUDIED	2
2.1	Scope of Study	2
2.2	Community Description	2
2.3	Principal Flood Problems	6
2.4	Flood Protection Measures	8
3.0	ENGINEERING METHODS	8
3.1	Hydrologic Analyses	8
3.2	Hydraulic Analyses	9
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	13
4.1	Flood Boundaries	14
4.2	Floodways	14
5.0	INSURANCE APPLICATION	23
5.1	Reach Determinations	24
5.2	Flood Hazard Factors	24
5.3	Flood Insurance Zones	24
5.4	Flood Insurance Rate Map Description	25

BEST COPY AVAILABLE

TABLE OF CONTENTS (Continued)

		Page
6.0	OTHER STUDIES	25
7.0	LOCATION OF DATA	28
8.0	REFERENCES AND BIBLIOGRAPHY	28
9.0	REVISIONS DESCRIPTION (Revised: May 15, 1986)	31
9.1	Purpose	31
9.2	Acknowledgments	31
9.3	Scope	31
9.4	Hydrologic and Hydraulic Analyses	31
9.5	Floodways	32
9.6	References and Bibliography	32

FIGURES

			Page
Figure	1	- Vicinity Map	3
Figure	2	- Looking East on 15 Mile Road at Red Run Drain, July 1967	7
Figure	3	- Looking South on Hayes Road, North of the Clinton River, June 1968	7
Figure	4	- Floodway Schematic	23

TABLES

			Page
Table	1	- Flooding Sources	4
Table	2	- Summary of Discharges	10
Table	3	- Floodway Data	15
Table	4	- Flood Insurance Zone Data	26
Table	5	- Revised Summary of Discharges	32

BEST COPY AVAILABLE

TABLE OF CONTENTS (Continued)

EXHIBITS

Exhibit 1 - Flood Profiles

Clinton River	Panels	01P - 03P
Red Run Drain	Panels	04P - 05P
Plum Brook	Panels	06P - 09P
Gibson Drain	Panel	10P
Chrissman Drain	Panels	11P - 12P
Big Beaver Creek	Panels	13P - 14P
Sterling Relief Drain	Panels	15P - 16P
Phiel Drain	Panels	17P - 18P
Chrissman Drain (Old Channel)	Panels	19P - 20P
Chrissman Drain (Overland Flow)	Panel	21P

Exhibit 2 - Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

BEST COPY AVAILABLE

FLOOD INSURANCE STUDY

CITY OF STERLING HEIGHTS,
MACOMB COUNTY, MICHIGAN

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Sterling Heights, Macomb County, Michigan, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert the City of Sterling Heights to the regular program of flood insurance by the Federal Insurance Administration. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain management.

1.2 Coordination

The identification of streams requiring detailed and approximate study was accomplished in meetings attended by personnel from the Federal Insurance Administration; the Michigan Department of Natural Resources; Johnson & Anderson, Inc.; and officials of the City of Sterling Heights in March 1976.

The hydrologic and hydraulic analyses for the streams studied in detail were coordinated with the Michigan Department of Natural Resources by the firm of Johnson & Anderson, Inc.

On January 22, 1980, the results of the study were reviewed and accepted at a final coordination meeting attended by personnel of the Federal Insurance Administration; the Michigan Department of Natural Resources; and Johnson & Anderson, Inc.; and officials of the City of Sterling Heights.

1.3 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by Johnson & Anderson, Inc., for the Federal Insurance Administration, under Contract No. H-3969. This work, which was completed in November 1977, covered all significant flooding sources affecting the City of Sterling Heights.

BEST COPY AVAILABLE

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Sterling Heights, Macomb County, Michigan. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction until 1982.

Approximate methods of analysis were used to study those areas having low development potential and/or minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the Federal Insurance Administration and the City of Sterling Heights.

Detailed study streams are outlined in Table 1. Flooding on Cady Drain, Gamble Drain, Sterling Relief Drain (west of Dodge Park Road), McInerney Drain, Moore Drain, Newth Drain, Cranberry Marsh Drain, Stadler Drain, Deiner Ditch Drain, Robinson Ditch, Canal Drain, Kerner Drain, Daus Drain, Utica Drain, Schluter Drain, Vokes Drain, Greens Ditch, and several unnamed tributaries in undeveloped parts of the city were studied by approximate methods.

2.2 Community Description

The City of Sterling Heights is located in west-central Macomb County, which is in the southeastern portion of Michigan's lower peninsula. The City of Sterling Heights is bounded by the City of Fraser and the Township of Clinton on the east. To the south lies the City of Warren. The City of Troy bounds Sterling Heights on the west and the Township of Shelby and the City of Utica bound Sterling Heights to the north. The population of Sterling Heights grew from 14,622 in 1960 to 61,365 in 1970 and to over 90,000 in 1977. Due to its location within the Detroit Metropolitan Area, the City of Sterling Heights is expected to continue to experience this accelerated population growth rate.

The residential development of Sterling Heights consists primarily of medium density housing in the form of large subdivisions and apartment complexes. Commercial development is typically restricted to strip areas along major highways and regional shopping centers. Industrial expansion in Sterling Heights has been rapid, primarily as a consequence of the post-World War II building boom.

The climate of Sterling Heights is affected by the proximity of the Great Lakes, which acts to modify temperature extremes through the year. The maximum monthly average of 72 degrees Fahrenheit (F.) occurs in July,

BEST COPY AVAILABLE

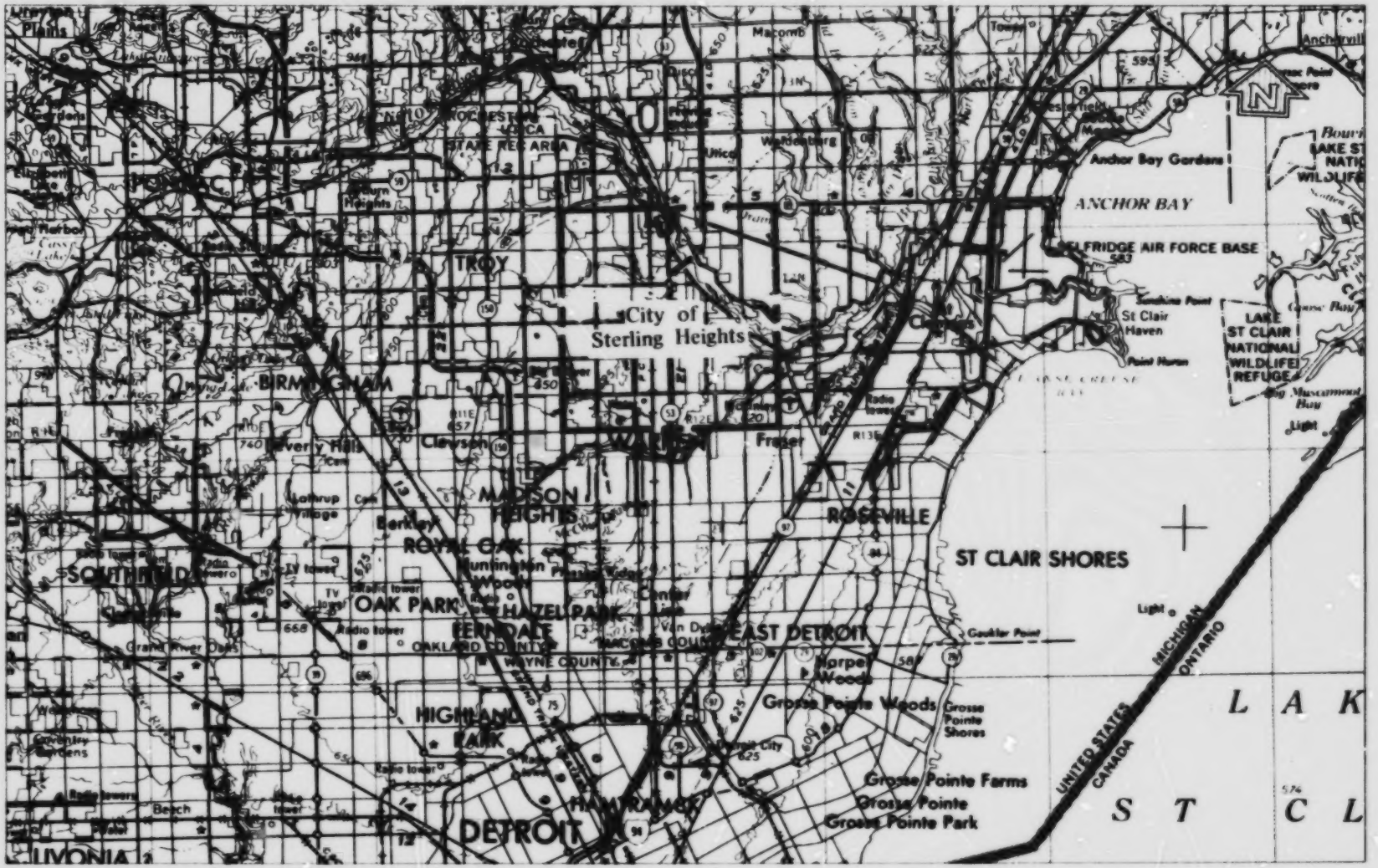


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

BEST COPY AVAILABLE

TABLE 1: FLOODING SOURCES

FLOODING SOURCE	DESCRIPTION OF STUDY LIMITS		DISTANCE (Miles)
	FROM	TO	
DETAILED FLOODING SOURCES			
CLINTON RIVER	Downstream Corporate Limits (Hayes Road)	Upstream Corporate Limits (Van Dyke Road)	7.4
RED RUN DRAIN	Downstream Corporate Limits (Confluence with Clinton River)	Upstream Corporate Limits (14 Mile Road)	3.25
PLUM BROOK	Mouth at Red Run Drain	Upstream Corporate Limits (Hall Road)	8.4
GIBSON DRAIN	Mouth at Plum Brook	Upstream Corporate Limits (Dequindre Road)	1.46
CHRISSMAN DRAIN	Mouth at Plum Brook	Upstream Corporate Limits (Hall Road)	2.18
BIG BEAVER CREEK	Downstream Corporate Limits (14 Mile Road)	Upstream Corporate Limits (Dequindre Road)	4.17
SHANAHAN DRAIN	Mouth at Big Beaver Creek	0.25 mile upstream of 16 Mile Road	0.57
PHIEL DRAIN	Mouth at Clinton River	Dodge Park Road	0.30

BEST COPY AVAILABLE

TABLE 1: FLOODING SOURCES (CONTINUED)

FLOODING SOURCE	DESCRIPTION OF STUDY LIMITS		DISTANCE (Miles)
	FROM	TO	
DETAILED FLOODING SOURCES			
STERLING RELIEF DRAIN	Mouth at Red Run Drain	0.7 mile upstream of Dodge Park Road	2.12
CHRISSMAN DRAIN (OLD CHANNEL)	Mouth at Plum Brook	Divergence with Chrissman Drain, 1/8 mile south of 18½ Mile Road	0.30
CHRISSMAN DRAIN (OVERLAND FLOW)	Convergence with Chrissman Drain just downstream of 19 Mile Road	Divergence with Chrissman Drain just upstream of 19 Mile Road	0.13

BEST COPY AVAILABLE

and the minimum monthly average of 24 degrees F. occurs in January. The average annual precipitation of 28 inches includes approximately 30 inches of snow.

The City of Sterling Heights is located in an area of fairly level topography, consisting primarily of post-glacial lake beds and glacial moraines. Soils of the area are generally sandy clays, underlain by an occasional stratum of silty sand.

The streams in the City of Sterling Heights are located entirely within the Clinton River drainage basin. The Clinton River flows in a southeasterly direction through the northeast corner of Sterling Heights. The Red Run Drain flows in a northeasterly direction from its headwaters in highly urbanized southeast Oakland County, through the Cities of Warren and Sterling Heights, to its confluence with the Clinton River in the western part of the Township of Clinton. Plum Brook flows from the northwestern part of Sterling Heights, where it is joined by Gibson and Chrissman Drains, in a southeasterly direction to its confluence with Red Run Drain in western Clinton Township. Big Beaver Creek, a tributary of Red Run Drain, flows in a southeasterly direction in the southwestern part of Sterling Heights and is joined in the western part of Sterling Heights by Spencer and Shanahan Drains. Phiel Drain flows east to its confluence with the Clinton River in eastern Sterling Heights. Sterling Relief Drain flows in an easterly direction in the southeastern corner of Sterling Heights before its confluence with Red Run Drain.

Flood plain development in the City of Sterling Heights exists primarily in industrial corridors and residential areas along the Clinton River and Plum Brook.

2.3 Principal Flood Problems

Some local flooding has occurred in areas within the Clinton River basin due to inadequate storm drainage. This type of flooding is usually experienced during the late winter and early spring, primarily due to snowmelt or rainfall on frozen or saturated ground. Other floods have been a result of localized intense rainfall during the summer.

Large magnitude floods have occurred within the Clinton River basin several times since the beginning of this century. Although the greatest observed flood occurred in 1902, the greatest flood of record occurred in April 1947. Other significant floods of lower magnitude occurred in June 1905, August 1914, February 1922, February 1938, May 1943, May 1948, April 1956, and June 1968. There are no return frequency estimations or discharge values available for these storms of record in Sterling Heights. Photographs of the floods of July 1967 and June 1968 are shown in Figures 2 and 3.

BEST COPY AVAILABLE

FIGURE 2. Looking East on 15 Mile Road at Red Run Drain, July 1967.

FIGURE 3. Looking South on Hayes Road, North of the Clinton River, June 1968.

BEST COPY AVAILABLE

2.4 Flood Protection Measures

A number of changes have been made to Red Run Drain which would affect flood stages. The most substantial change has been the improvement of channel hydraulic characteristics. The construction of Henry Graham Drain in Troy has significantly reduced the drainage area of Big Beaver Creek and Spencer Drain. The construction of Sterling Relief Drain has further reduced the drainage area of Big Beaver Creek in addition to providing a more adequate drainage plan for the City of Sterling Heights. The construction on Sterling Relief Drain consists of a four-foot-diameter underdrain topped by an open channel, which extends along the reach of the drain. The U.S. Army Corps of Engineers (COE) is in the early stages of studying alternatives which could be used to alleviate floods or flood damage; however, no flood protection measures are planned within the foreseeable future.

3.0 ENGINEERING METHODS

For flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10, 50, 100, and 500 years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect 1976 conditions in the watersheds of the streams.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail in the community.

The frequency discharge data for the detailed study streams were computed using the Unit Hydrograph Infiltration Capacity Method developed by Dr. Ernest F. Brater (Reference 1). This method utilizes the relationship of streamflow, drainage area, and population density. Urbanization and channel conditions were considered for 1976 conditions. As urbanization affects imperviousness and channel conditions, flows can be expected to increase. Two other methods, a log-Pearson Type III gage analysis (Reference 2) and the Soil Conservation Service (SCS) flood routing techniques (Reference 3) were used in conjunction with the Brater Method. For the log-Pearson Type III analysis the data from the U.S. Geological Survey gages on Plum Brook at Utica (No. 0416340, years of record 1965-1979) and on Plum Brook just downstream of Utica (No. 0416350, years of record 1954 to 1966) were used. Discharges for the approximate study streams were also determined using the Brater method.

The decrease in discharge in Red Run Drain from Schoenherr Relief Drain to 15 Mile Road is due to overbank flood plain storage. The decrease in peak discharges for larger recurrence intervals at the mouth of Chrissman

Drain is due to the effect of the tail water of Plum Brook, into which the culvert empties. This effect increases with increasing discharges into Plum Brook, therefore producing decreasing discharges at the mouth of Chrissman Drain.

Divergent flow of Chrissman Drain occurs at its culvert. Part of Chrissman Drain flows through the culvert, and the remainder flows along the old channel, creating Chrissman Drain (Old Channel). Chrissman Drain (Overland Flow) results from divergent flow around high ground in the area of 19 Mile Road.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 2.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

All cross sections were field surveyed. Field surveys were conducted from October 1976 through January 1977. Valley sections were located in places representing a typical stream reach.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness coefficients (Manning's "n") for computations on the streams in the City of Sterling Heights were based on conditions in the watershed of the stream typical of summer. The values for the Manning's "n" coefficients were determined through field observation and comparison with Chow's Open Channel Hydraulics (Reference 4). The channel roughness factors ranged from 0.025 to 0.05; the overbank roughness factors ranged from 0.03 to 0.10.

Water-surface elevations of floods of the selected recurrence intervals for the streams studied in detail were calculated by using the COE HEC-2 step-backwater computer program (Reference 5).

Flood profiles for the streams studied by detailed methods were drawn showing computed water-surface elevations for floods of the selected recurrence intervals (Exhibit 1). The Clinton River profile calculations were begun at the corporate limit. The starting water-surface elevations were obtained from the Township of Clinton Flood Insurance Study (Reference 6).

The Red Run Drain profile was begun at the corresponding Clinton River flood elevations at the confluence which were obtained from the Township

BEST COPY AVAILABLE

TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
CLINTON RIVER					
Just above Red Run Drain	318	4,720	7,280	8,220	11,300
At Section T	315	4,680	7,220	8,150	11,200
RED RUN DRAIN					
At Mouth	140.2	11,200	17,200	19,100	25,700
At Sterling Relief Drain	111.5	10,600	16,200	17,800	23,800
At 15 Mile Road	105	10,100	15,400	17,000	22,800
At Schoenherr Relief Drain	105	10,700	16,300	18,700	26,200
PLUM BROOK					
At Mouth	27.0	1,540	2,240	2,560	3,500
350 Feet Downstream of Section B	26.5	1,470	2,150	2,450	3,350
At Section B	26.2	1,460	2,130	2,430	3,330
Just Downstream of Section O	24.3	1,350	1,970	2,250	3,080
Just Upstream of Section O	20.9	1,240	1,810	2,070	2,830
Just Downstream of Chrissman Drain	20.0	1,200	1,760	2,000	2,750
Just Upstream of Chrissman Drain	18.3	1,140	1,660	1,890	2,600
1,200 Feet Downstream of Ryan Road	17.6	1,110	1,620	1,850	2,540
1,000 Feet Downstream of Ryan Road	16.7	1,080	1,570	1,740	2,460
Just Downstream of Mouth of Gibson Drain	16.7	1,070	1,560	1,740	2,450
10 Feet Upstream of Mouth of Gibson Drain	4.0	455	660	750	1,050
200 Feet Upstream of Mouth of Gibson Drain	3.9	455	660	740	1,050

BEST COPY AVAILABLE

TABLE 2 SUMMARY OF DISCHARGES (CONTINUED)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
PLUM BROOK (CONTINUED)					
640 Feet Upstream of Mouth of Gibson Drain	2.9	380	550	620	880
200 Feet Upstream of 19 Mile Road	2.7	365	520	590	840
2,400 Feet Upstream of 19 Mile Road	2.2	325	465	530	750
GIBSON DRAIN					
At Mouth	12.7	910	1,320	1,470	2,070
CHRISSMAN DRAIN					
At Mouth	1.8	248	235	230	215
Just Upstream of Culvert	1.8	276	392	450	636
Just Upstream of Mound Road	0.8	161	227	265	375
Just Upstream of Hanks Lane	0.7	154	217	250	355
Just Downstream of Convergence of Overland Flow at 19 Mile Road	0.6	133	188	217	305
Just Upstream of Divergence of Overland Flow at 19 Mile Road	0.6	133	187	217	305
CHRISSMAN DRAIN (OLD CHANNEL)					
At Mouth	1.8	28	157	220	421
CHRISSMAN DRAIN (OVERLAND FLOW)					
At Mouth	0.6	17	38	54	115

BEST COPY AVAILABLE

TABLE 2 - SUMMARY OF DISCHARGES (CONINTUED)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
[illegible] BEAVER [illegible]					
	3.9	680	1,020	1,170	1,650
	2.9	650	980	1,140	1,600
[illegible] 15 Mile	2.3	590	900	1,040	1,450
[illegible] 1o Mile	1.1	340	520	600	840
[illegible] of Mouth of [illegible] Drain	0.9	290	440	510	710
Just Upstream of Mouth of Shanahan Drain	0.5	125	190	215	305
	0.1	60	90	100	135
SHANAHAN DRAIN					
At Mouth	0.4	100	150	175	245
PHIEL DRAIN					
At Mouth	0.4	200	290	330	450
STERLING RELIEF DRAIN					
At Mouth	6.2	875	1,470	1,800	2,690

COPY AVAILABLE

of Clinton Flood Insurance Study (Reference 6). Likewise, the Plum Brook profile was begun at its confluence with Red Run Drain, with the Red Run Drain flood elevations at that point being used. The profiles of Gibson Drain, Chrissman Drain (Old Channel), and Chrissman Drain (Overland Flow) were begun at their respective confluences with Plum Brook and used Plum Brook elevations at the confluences as starting water-surface elevations.

The Big Beaver Creek profile calculations were begun at the corporate limit. The starting water-surface elevations were obtained from the City of Warren Flood Insurance Study (Reference 7) which is being conducted concurrently with this study. The profiles for Shanahan Drain were begun at the confluence at Big Beaver Creek and used Big Beaver Creek elevations at the confluences as starting water-surface elevations.

The Phiel Drain profile calculations were begun at its confluence with the Clinton River. The water-surface elevations in the Clinton River were used as starting water-surface elevations for the Phiel Drain. The Sterling Relief Drain computations began at its confluence with Red Run Drain and used the Red Run Drain elevations at the confluence as starting water-surface elevations. For these tributaries whose starting water-surface elevations were obtained from the main stream, a time of maximum discharge was determined separately; therefore, the peaks may not be coincident with the main stream.

For areas studied by approximate methods, the 100-year flood was determined by either extending the flow-stream depth relationship determined in the detailed study area; relating flow, area, and depth in an approximated area to a similar one studied by detailed methods; or by using a Map of Flood Prone Areas (Reference 8).

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

BEST COPY AVAILABLE

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Insurance Administration as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each flooding source studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using photogrammetric methods (Reference 9). Approximate areas were delineated by field inspection, topographic maps, and the Flood Hazard Boundary Map (References 8, 10, and 11).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity and increases flood heights, thus increasing flood hazard in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment in order that the 100-year flood be carried without substantial increases in flood heights. As minimum standards, the Federal Insurance Administration limits such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The Michigan Flood Plain Act (Act 167, P.A. 1968), however, limits flood plain encroachment to that which will cause only insignificant increases in flood heights (less than 0.1 foot) (Reference 12).

In general, the technique used to define the floodways in this report involved describing the sweep and extent of moving floodwater by applying engineering judgment and basic rules of hydraulics to the flooded outline maps. With this technique, the areas in the floodway fringe are areas of ponded water. Only areas with no conveyance (water-carrying ability) are included in the floodway fringe. The results of the floodway computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 3).

BEST COPY AVAILABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
CLINTON RIVER								
A	17.260	799	6276	1.3	600.9	600.9	600.9	0.0
B	17.593	888	7395	1.1	601.2	601.2	601.2	0.0
C	18.286	893	4652	1.8	601.8	601.8	601.8	0.0
D	18.470	1062	6199	1.3	602.0	602.0	602.0	0.0
E	18.488	1129	6456	1.3	602.1	602.1	602.1	0.0
F	18.718	882	5222	1.6	602.2	602.2	602.2	0.0
G	19.233	802	3991	2.1	602.6	602.6	602.6	0.0
H	19.646	605	3710	2.2	603.6	603.6	603.6	0.0
I	19.784	550	1083	7.6	604.3	604.3	604.3	0.0
J	19.805	500	1323	6.2	604.9	604.9	604.9	0.0
K	20.116	888	5974	1.4	606.3	606.3	606.3	0.0
L	21.013	931	4767	1.7	607.6	607.6	607.6	0.0
M	21.375	1131	4417	1.9	608.5	608.5	608.5	0.0
N	21.754	844	4140	2.0	609.6	609.6	609.6	0.0
O	21.824	913	4541	1.8	609.9	609.9	609.9	0.0
P	21.846	891	4620	1.8	610.3	610.3	610.3	0.0
Q	22.099	593	2644	3.1	611.5	611.5	611.5	0.0
R	22.405	240	1625	5.1	612.9	612.9	612.9	0.0
S	22.434	194	1323	6.2	613.2	613.2	613.2	0.0
T	22.453	195	1360	6.0	613.4	613.4	613.4	0.0
U	22.589	736	4013	2.0	614.2	614.2	614.2	0.0
V	22.970	654	2578	3.2	614.7	614.7	614.7	0.0
W	23.500	201	1394	5.8	618.6	618.6	618.6	0.0
X	23.545	280	1200	6.8	620.0	620.0	620.0	0.0
Y	24.059	423	4221	1.9	622.3	622.3	622.3	0.0
Z	24.477	810	2314	3.5	623.1	623.1	623.1	0.0

[1]MILES ABOVE MOUTH

BEST COPY AVAILABLE

REVISED: 5/15/86

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOODWAY DATA

CLINTON RIVER

BLANK PAGE

BLANK PAGE

BLANK PAGE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
RED RUN DRAIN								
A	1039	223[2]	2931	5.5	601.9	601.9	601.9	0.0
B	1143	175[2]	2558	6.3	602.7	602.7	602.7	0.0
C	1223	344[2]	3955	4.1	603.5	603.5	603.5	0.0
D	3180	205	3019	5.3	604.0	604.0	604.0	0.0
E	5720	256	3047	4.9	604.6	604.6	604.6	0.0
F	8270	542	5278	2.8	605.1	605.1	605.1	0.0
G	8394	731	5471	2.7	605.6	605.6	605.6	0.0
H	9594	709	6168	2.7	605.7	605.7	605.7	0.0
I	9676	804	4045	4.1	605.7	605.7	605.8	0.1
J	11,596	509	3700	4.5	606.0	606.0	606.0	0.0
K	13,196	298	3375	4.9	606.4	606.4	606.4	0.0
L	14,796	178	2556	6.5	606.8	606.8	606.8	0.0
M	16,096	250	2830	5.0	607.5	607.5	607.5	0.0
N	16,418	280	2662	5.4	607.8	607.8	607.8	0.0
O	16,768	423	4439	3.2	608.2	608.2	608.2	0.0
P	17,168	490	5342	2.7	608.4	608.4	608.4	0.0

[1]FEET ABOVE MOUTH
[2]THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS

REVISED: 5/15/86

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOODWAY DATA

RED RUN DRAIN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
PLUM BROOK								
A	875	1308	5105	0.5	602.6	602.6	602.6	0.0
B	3080	500	4282	0.6	602.7	602.7	602.7	0.0
C	4680	485	2660	0.9	602.8	602.8	602.8	0.0
D	6200	1164	3670	0.7	602.9	602.9	602.9	0.0
E	6279	1178	3866	0.6	602.9	602.9	602.9	0.0
F	6447	1181	3159	0.8	603.0	603.0	603.0	0.0
G	7325	578	2411	1.0	603.0	603.0	603.0	0.0
H	8475	556	2087	1.2	603.1	603.1	603.1	0.0
I	9240	304	846	2.9	603.2	603.2	603.2	0.0
J	10,875	322	1237	2.0	604.5	604.5	604.5	0.0
K	12,280	114	584	4.2	605.9	605.9	605.9	0.0
L	12,356	93	853	2.8	606.8	606.8	606.8	0.0
M	13,470	514	1724	1.4	607.5	607.5	607.5	0.0
N	14,920	230	1009	2.4	608.2	608.2	608.2	0.0
O	17,000	166	546	4.1	609.6	609.6	609.6	0.0
P	19,025	176	483	4.3	613.8	613.8	613.8	0.0
Q	19,149	260	775	2.7	614.9	614.9	614.9	0.0
R	19,571	280	976	2.1	615.2	615.2	615.2	0.0
S	20,325	423	1680	1.2	615.6	615.6	615.6	0.0
T	21,759	367	1112	1.9	616.0	616.0	616.0	0.0
U	21,836	354	1023	2.0	616.0	616.0	616.0	0.0
V	23,275	92	389	5.3	616.6	616.6	616.6	0.0
W	23,410	44	290	7.1	617.5	617.5	617.5	0.0
X	24,050	385	1546	1.3	619.0	619.0	619.0	0.0
Y	24,665	59	368	5.6	619.5	619.5	619.5	0.0
Z	24,757	45	437	4.7	619.7	619.7	619.7	0.0

[1]FEET ABOVE MOUTH

BEST COPY AVAILABLE

REVISED: 5/15/86

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOODWAY DATA

PLUM BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
PLUM BROOK								
AA	25,435	192	727	2.8	620.6	620.6	620.6	0.0
AB	25,565	230	729	2.6	620.7	620.7	620.7	0.0
AC	26,765	98	371	5.1	622.0	622.0	622.0	0.0
AD	26,947	24	212	8.9	622.8	622.8	622.8	0.0
AE	27,975	620	2005	0.9	624.7	624.7	624.7	0.0
AF	29,270	377	822	2.3	625.1	625.1	625.1	0.0
AG	29,460	478	1569	1.2	627.4	627.4	627.4	0.0
AH	30,470	149	854	2.2	627.6	627.6	627.6	0.0
AI	31,350	262	826	2.2	628.2	628.2	628.2	0.0
AJ	33,025	441	1156	1.5	629.7	629.7	629.7	0.0
AK	33,143	497	2052	0.8	631.6	631.6	631.6	0.0
AL	34,310	352	994	0.6	631.7	631.7	631.7	0.0
AM	35,261	127	164	3.8	632.5	632.5	632.5	0.0
AN	35,485	30	77	8.1	633.8	633.8	633.8	0.0
AO	36,810	256	344	1.8	640.2	640.2	640.2	0.0
AP	36,984	390	1183	0.5	642.7	642.7	642.7	0.0
AQ	38,210	281	268	2.2	644.2	644.2	644.2	0.0
AR	39,410	177	179	3.3	650.1	650.1	650.1	0.0
AS	41,110	345	377	1.4	658.1	658.1	658.1	0.0
AT	42,610	263	262	2.0	666.5	666.5	666.5	0.0
AU	44,110	105	150	2.9	674.9	674.9	674.9	0.0

[1]FEET ABOVE MOUTH

BEST COPY AVAILABLE

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOODWAY DATA

PLUM BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
GIBSON DRAIN								
A	165	216	1020	1.4	631.7	631.7	631.7	0.0
B	1620	512	2396	0.6	633.0	633.0	633.0	0.0
C	2055	299	800	1.8	633.0	633.0	633.0	0.0
D	3255	317	792	1.9	633.8	633.8	633.8	0.0
E	4181	36	260	5.7	635.6	635.6	635.6	0.0
F	5615	483	888	1.7	636.6	636.6	636.6	0.0
G	6515	278	555	2.6	639.8	639.8	639.8	0.0
H	7505	865	1100	1.2	641.4	641.4	641.4	0.0
CHRISSMAN DRAIN								
A	963	143	239	1.0	623.1	623.1	623.1	0.0
B	1545	8	47	7.7	623.5	632.5	623.5	0.0
C	1605	9	61	5.9	624.3	624.3	624.3	0.0
D	2640	156	203	1.8	629.8	629.8	629.8	0.0
E	2810	105	172	2.1	630.0	630.0	630.0	0.0
F	3168	578	764	0.5	632.9	632.9	632.9	0.0
G	4020	130	185	1.4	633.0	633.0	633.0	0.0
H	4217	157	266	0.9	634.3	634.3	634.3	0.0
I	5115	328	149	1.1	634.7	634.7	634.7	0.0
J	5205	400	331	0.5	635.2	635.2	635.2	0.0
K	5704	200	143	1.1	636.1	636.1	636.1	0.0
L	6295	486	334	0.6	636.7	636.7	636.7	0.0
M	7655	548	238	0.9	638.7	638.7	638.7	0.0
N	9165	870	314	0.7	642.7	642.7	642.7	0.0
O	10,495	553	429	0.5	644.1	644.1	644.1	0.0
P	11,525	525	272	0.8	647.6	647.6	647.6	0.0

[1]FEET ABOVE MOUTH

BEST COPY AVAILABLE

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOODWAY DATA

GIBSON DRAIN - CHRISSMAN DRAIN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
BIG BEAVER CREEK								
A	5335	40	399	3.6	609.8	609.8	609.8	0.0
B	5800	474	1762	0.7	610.2	610.2	610.2	0.0
C	6330	62	422	2.8	610.3	610.3	610.3	0.0
D	6407	30	260	4.5	611.1	611.1	611.1	0.0
E	7400	92	619	1.9	612.0	612.0	612.0	0.0
F	9000	89	528	2.2	612.6	612.6	612.6	0.0
G	10,010	66	470	2.5	613.1	613.1	613.1	0.0
H	10,122	36	364	3.2	613.2	613.2	613.2	0.0
I	10,302	36	340	3.4	613.5	613.5	613.5	0.0
J	11,400	98	323	3.5	614.4	614.4	614.4	0.0
K	13,200	160	351	3.3	616.8	616.8	616.8	0.0
L	14,004	89	442	2.6	617.5	617.5	617.5	0.0
M	14,900	49	283	3.7	618.1	618.1	618.1	0.0
N	16,500	67	346	3.0	619.4	619.4	619.4	0.0
O	17,800	59	318	2.5	620.2	620.2	620.2	0.0
P	18,125	39	303	2.6	620.4	620.4	620.4	0.0
Q	18,700	310	696	1.1	620.7	620.7	620.7	0.0
R	19,800	310	685	0.9	621.0	621.0	621.0	0.0
S	20,407	15	79	7.6	621.3	621.3	621.3	0.0
T	20,619	345	1301	0.5	623.2	623.2	623.2	0.0
U	21,100	378	652	0.8	623.2	623.2	623.2	0.0
V	22,300	306	370	0.9	623.5	623.5	623.5	0.0
W	23,700	189	180	1.9	624.3	624.3	624.3	0.0
X	24,800	158	128	1.7	625.8	625.8	625.8	0.0

[1]FEET ABOVE MOUTH

BEST COPY AVAILABLE

REVISED: 5/15/86

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI

(MACOMB CO.)

FLOODWAY DATA

BIG BEAVER CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
STERLING RELIEF DRAIN								
A	30	280	838	2.2	604.2	603.2[2]	603.2	0.0
B	1360	117	708	2.5	604.2	603.4[2]	603.4	0.0
C	1559	125	895	2.0	605.0	605.0	605.0	0.0
D	4590	121	669	2.7	605.3	605.3	605.3	0.0
E	7380	106	576	3.1	606.0	606.0	606.0	0.0
F	7540	104	296	6.1	606.0	606.0	606.0	0.0

[1]FEET ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM RED RUN DRAIN

BEST COPY AVAILABLE

REVISED: 5/15/86

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOODWAY DATA

STERLING RELIEF DRAIN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
PHIEL DRAIN								
A	322	5	50	6.7	606.8	605.0[3]	605.0	0.0
B	840	71	161	2.1	606.8	606.4[3]	606.4	0.0
C	1580	34	110	3.0	607.2	607.2	607.2	0.0
CHRISSMAN DRAIN (OLD CHANNEL)								
A	590	35	70	3.1	620.7	618.5[4]	618.5	0.0
B	1159	11	36	6.1	620.7	620.3[4]	620.3	0.0
CHRISSMAN DRAIN (OVERLAND FLOW)								
A	570[2]	243	102	0.5	635.2	635.2	635.2	0.0

[1]FEET ABOVE MOUTH
[2]FEET ABOVE CONVERGENCE WITH CHRISSMAN DRAIN
[3]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM CLINTON RIVER
[4]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM PLUM BROOK

BEST COPY AVAILABLE

REVISED: 5/15/86

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOODWAY DATA

PHIEL DRAIN - CHRISSMAN DRAIN (OLD CHANNEL) - CHRISSMAN DRAIN (OVERLAND FLOW)

Portions of the floodways for Red Run Drain, the Clinton River, and Big Beaver Creek extend along or beyond the corporate boundaries.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 4.

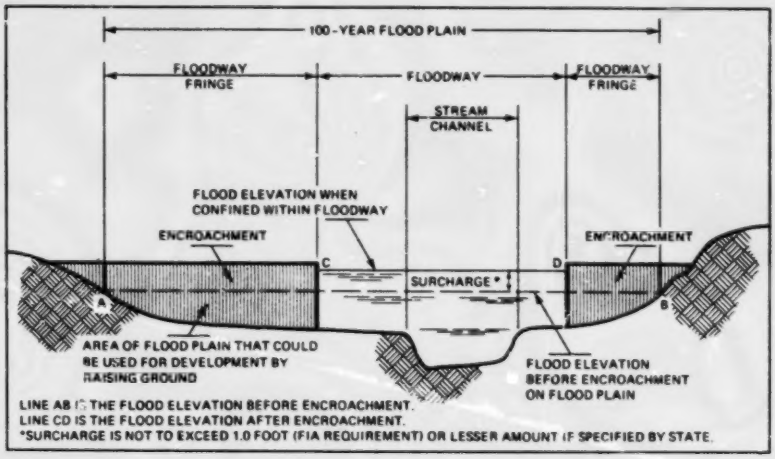

100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FIGURE 4 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Insurance Administration has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source affecting the City of Sterling Heights.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the City of Sterling Heights are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 4).

5.2 Flood Hazard Factors

The Flood Hazard Factor is the Federal Insurance Administration device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their Flood Hazard Factors are used to set actuarial insurance premium rate tables based on Flood Hazard Factors from 005 to 200.

The Flood Hazard Factor for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the Flood Hazard Factor is 005; if the difference is 1.4 feet, the Flood Hazard Factor is 015; if the difference is 5.0 feet, the Flood Hazard Factor is 050. When the difference between the 10-and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the Flood Hazard Factor is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective Flood Hazard Factors, the entire incorporated area of the City of Sterling Heights was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations

BEST COPY AVAILABLE

are shown or Flood Hazard Factors determined.

Zones A1-A7, A9: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to Flood Hazard Factor.

Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 4, "Flood Insurance Zone Data," summarizes the flood elevation differences, Flood Hazard Factors, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Sterling Heights is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Insurance Administration.

6.0 OTHER STUDIES

The COE has performed a number of studies in the study area. Their report on the Clinton River, published in August 1964, is the most recent in providing backwater curve information (Reference 13). Since that time, a major flood occurred (in June 1968) which has made available more pertinent hydrologic information. This study and the above-mentioned study are not compatible due to more recent information used. This study is compatible with the adjoining studies for the Township of Clinton, the City of Fraser, the City of Warren, the City of Utica, and the Township of Shelby (References 6, 14, 7, 15 and 16).

BEST COPY AVAILABLE

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
CLINTON RIVER							
REACH 1	0015,0020	−2.3	−0.6	1.6	025	A5	VARIES—SEE MAP
RED RUN DRAIN							
REACH 1	0015	−3.0	−0.5	1.8	030	A6	VARIES—SEE MAP
REACH 2	0015	−4.3	−0.5	1.6	045	A9	VARIES—SEE MAP
PLUM BROOK							
REACH 1	0015	−3.1	−0.7	0.6	030	A6	VARIES—SEE MAP
REACH 2	0010,0015,0020	−2.1	−0.5	1.1	020	A4	VARIES—SEE MAP
REACH 3	0010	−0.5	−0.1	0.4	005	A1	VARIES—SEE MAP
GIBSON DRAIN							
REACH 1	0010	−0.9	−0.2	0.8	010	A2	VARIES—SEE MAP
CHRISSMAN DRAIN							
REACH 1	0010	−0.4	−0.1	0.3	005	A1	VARIES—SEE MAP
BIG BEAVER CREEK							
REACH 1	0005	−2.1	−0.6	1.4	020	A4	VARIES—SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

REVISED: 5/15/86

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOOD INSURANCE ZONE DATA

CLINTON RIVER - RED RUN DRAIN - PLUM BROOK - GIBSON DRAIN - CHRISSMAN DRAIN - BIG BEAVER CREEK

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
STERLING RELIEF DRAIN							
REACH 1	0015	−2.8	−2.0	3.8	030	A6	VARIES–SEE MAP
PHIEL DRAIN							
REACH 1	0020	−2.2	−0.6	1.8	020	A4	VARIES–SEE MAP
CHRISSMAN DRAIN (OLD CHANNEL)							
REACH 1	0010	−2.1	−0.6	2.3	020	A4	VARIES-SEE MAP
CHRISSMAN DRAIN (OVERLAND FLOW)							
REACH 1	0010	−0.2	−0.1	0.2	005	A1	VARIES-SEE MAP

[1] FLOOD INSURANCE RATE MAP PANEL
[2] WEIGHTED AVERAGE
[3] ROUNDED TO NEAREST FOOT

BEST COPY AVAILABLE

REVISED: 5/15/86

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOOD INSURANCE ZONE DATA

STERLING RELIEF DRAIN - PHIEL DRAIN - CHRISSMAN DRAIN (OLD CHANNEL) - CHRISSMAN DRAIN (OVERLAND FLOW)

A Flood Hazard Boundary Map has been published by the Federal Insurance Administration (Reference 11). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the Insurance and Mitigation Division, Federal Emergency Management Agency, One North Dearborn Street, Chicago, Illinois 60602.

8.0 REFERENCES AND BIBLIOGRAPHY

1. National Environmental Research Center, Rainfall-Runoff Relations on Urban and Rural Areas, E.F. Brater and J.D. Sherill, Columbus, Ohio.

2. U.S. Water Resources Council, Bulletin No. 17, Guidelines for Determining Flood Flow Frequency, March 1976.

3. U.S. Department of Agriculture, Soil Conservation Service, Central Technical Unit, Technical Release No. 20, Computer Program for Project Formulation, Hydrology, May 1965.

4. Chow, V.T., Open-Channel Hydraulics. New York: McGraw-Hill Book Company, Inc., 1959.

5. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profile User's Manual, 1973.

6. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Clinton, Michigan, (in progress).

7. ----------, Topographic Study, City of Warren, Michigan, (in progress).

8. U.S. Geological Survey, Map of Flood Prone Areas, Scale 1:24000, Contour Interval 10 feet: Mt. Clemens, West Quadrangle, 1974.

9. Abrams Aerial Survey Corporation, Topographic Map, Scale 1:9600: Sterling Heights, Michigan, April 1976 (Photography); September 1977 (Mapping).

10. U.S. Geological Survey, 7.5 Minute Series Topographic Map, Scale 1:24000, Contour Interval 10 feet: Mt. Clemens, West Quadrangle, 1968, (photorevised) 1973.

BEST COPY AVAILABLE

11. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Sterling Heights, Michigan, September 1979.

12. State of Michigan, Flood Plain Control Act of 1968, Act 245, P.A. 1928 as amended by Act 167, P.A. 1968, Michigan Water Resources Commission, Lansing, Michigan, 1968.

13. U.S. Army Corps of Engineers, Detroit District, Clinton River, Michigan Flood Plain Information Report on the Main River and Main Branch in Macomb County, 1964.

14. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Fraser, Michigan, (in progress).

15. ----------, Flood Insurance Study, City of Utica, Michigan, (in progress).

16. ----------, Flood Insurance Study, Township of Shelby, Michigan, (in progress).

King, Horace William and Ernest F. Brater, Handbook of Hydraulics, Fifth Edition. New York: McGraw-Hill Book Company, Inc., 1963.

Macomb County Planning Commissioner, Data Book, 1974.

Southeast Michigan Council of Governments, Population Projections, Selected Small Area Forecast Version, 1974.

State of Michigan, Subdivision Control Act of 1967, Act 288, P.A. 1967 as amended, Michigan Water Resources Commission, Lansing, Michigan, 1967.

U.S. Army Corps of Engineers, Detroit District, Post Flood Report of Southeast Michigan Flood of June 25-27, 1968, 1969.

----------, Hydrologic Engineering Center, Training Document No. 6, Application of the HEC-2 Bridge Routines, June 1974.

U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Engineering Circular No. 5, Hydraulic Charts for the Selection of Highway Culverts.

U.S. Geological Survey, Gazetteer of Hydrologic Data for the Clinton River Basin, Southeastern Michigan, J.O. Nowlin, June 1971.

----------, Measurement of Peak Discharges at Dams by Indirect Methods, 1968.

BEST COPY AVAILABLE

———————————, 7.5 Minute Series Topographic Maps, Scale 1:24000: Warren Quadrangle, 1968, (photorevised) 1973.

U.S. Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years, Washington, D.C., May 1961.

BEST COPY AVAILABLE

9.0 REVISIONS DESCRIPTION (Revised: May 15, 1986)

9.1 Purpose

The purpose of this Flood Insurance Study Revisions Description is to incorporate revised data into this currently effective Flood Insurance Study for the City of Sterling Heights, Macomb County, Michigan. This Revisions Description is intended to provide updated information that aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

9.2 Acknowledgments

The hydrologic and hydraulic analyses for this Revisions Description were performed by the Michigan Department of Natural Resources (DNR). The Federal Emergency Management Agency (FEMA) reviewed and accepted these data for purposes of this revision.

9.3 Scope

The entire reach of Red Run Drain within the City of Sterling Heights has been restudied. The Red Run Drain backwater, previously shown on the profiles for the Clinton River, Plum Brook, Big Beaver Creek, and Sterling Relief Drain, has been revised to reflect the new elevations on Red Run Drain.

9.4 Hydrologic and Hydraulic Analyses

Revised discharges for Red Run Drain were computed by the Michigan DNR. The flood discharges were developed using the U.S. Army Corps of Engineers (COE) computer model HEC-SAM (Reference 1), which is a combination of several models allowing hydrologic, economics, and environmental analyses. The HEC-SAM model also contains a computerized data base consisting of resource variables within the watershed, such as land use, hydrologic subbasins, and slope.

Hydrologic routing in the HEC-SAM model uses HEC-1 (Reference 2), and has considered the additional storage in the Twelve Towns Drainage System as well as head loss in the pollution control structure at the outlet. Neither factor had been considered in previous analyses and, as a result, the 100-year floodflows have been reduced by about 20 to 25 percent. The peak flows out of the Twelve Towns Drainage System have been routed downstream using the HEC-1 capabilities of the HEC-SAM model.

The revised discharges for Red Run Drain are shown in Table 5, Revised Summary of Discharges.

BEST COPY AVAILABLE

TABLE 5 - REVISED SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
RED RUN DRAIN					
at mouth	140	10,780	15,910	17,390	23,340
just upstream of the confluence of Plum Brook	113	10,060	14,560	16,040	21,540
at 15-Mile Road	105	9,360	13,680	14,820	19,310

The starting water-surface elevations for Red Run Drain were obtained from a DAMBRK analysis (Reference 3), which modeled the confluence of Red Run Drain and the Clinton River. The revised flood profiles were computed using the COE HEC-2 step-backwater computer model (Reference 4). The cross-section data and Mannings "n" values used in this reanalysis remain unchanged from the original model.

Drainage was improved along Big Beaver Creek and Shanahan Drain by the installation of storm sewers to route flow from the 10-, 50-, and 100-year floods into a storm-water retention basin along Shanahan Drain. Since the 100-year discharges are contained within the storm sewers, the reach of Big Beaver Creek from the confluence of Shanahan Drain to the upstream corporate limits and the entire length of Shanahan Drain including an unnamed tributary to Shanahan Drain have been removed from the Special Flood Hazard Area.

All flood information for this reach of Big Beaver Creek, Shanahan Drain, and the unnamed tributary to Shanahan Drain has been deleted from the original Flood Insurance Study. These areas are now shown on the Flood Insurance Rate Map and Flood Boundary and Floodway Map as moderate flood hazard areas.

9.5 Floodways

Floodway computations for Red Run Drain were revised as a result of revised hydrology and hydraulics. The floodways were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was revised and are presented in Table 3, Floodway Data.

9.6 References and Bibliography

1. U.S. Army Corps of Engineers, Detroit District, Working Paper On Clinton River Watershed Study and HEC-SAM Model, 1983.

2. ———, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, User's Manual, 1981.

BEST COPY AVAILABLE

3. National Weather Service (NWS), Office of Hydrology, DAMBRK: The NWS Dam Break Flood Forecasting Model, D.L. Fread, Silver Spring, Maryland, 1982.

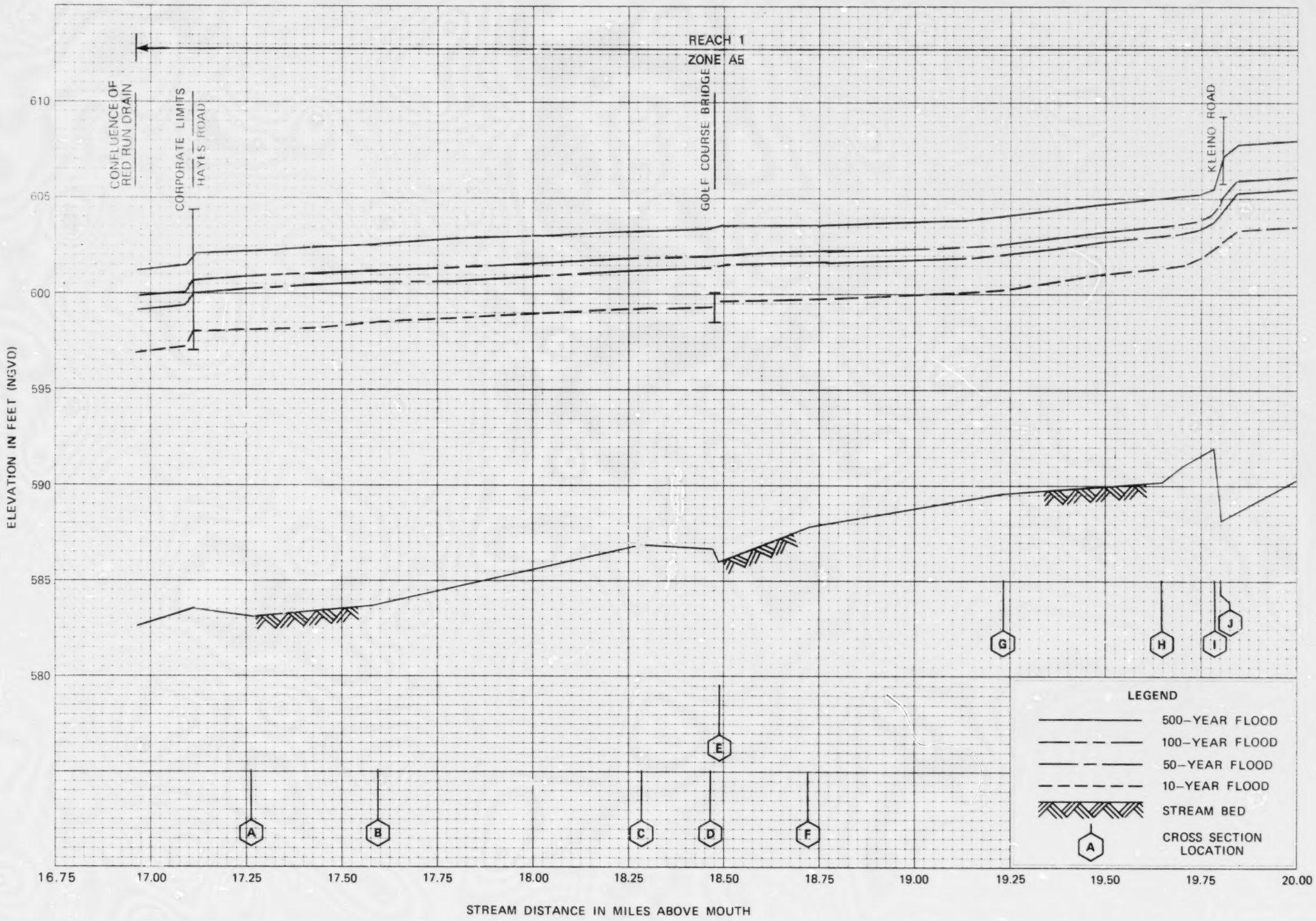
4. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles Generalized Computer Program, Davis, California, November 1976.

BEST COPY AVAILABLE

BLANK PAGE

BLANK PAGE

BLANK PAGE



FLOOD PROFILES

CLINTON RIVER

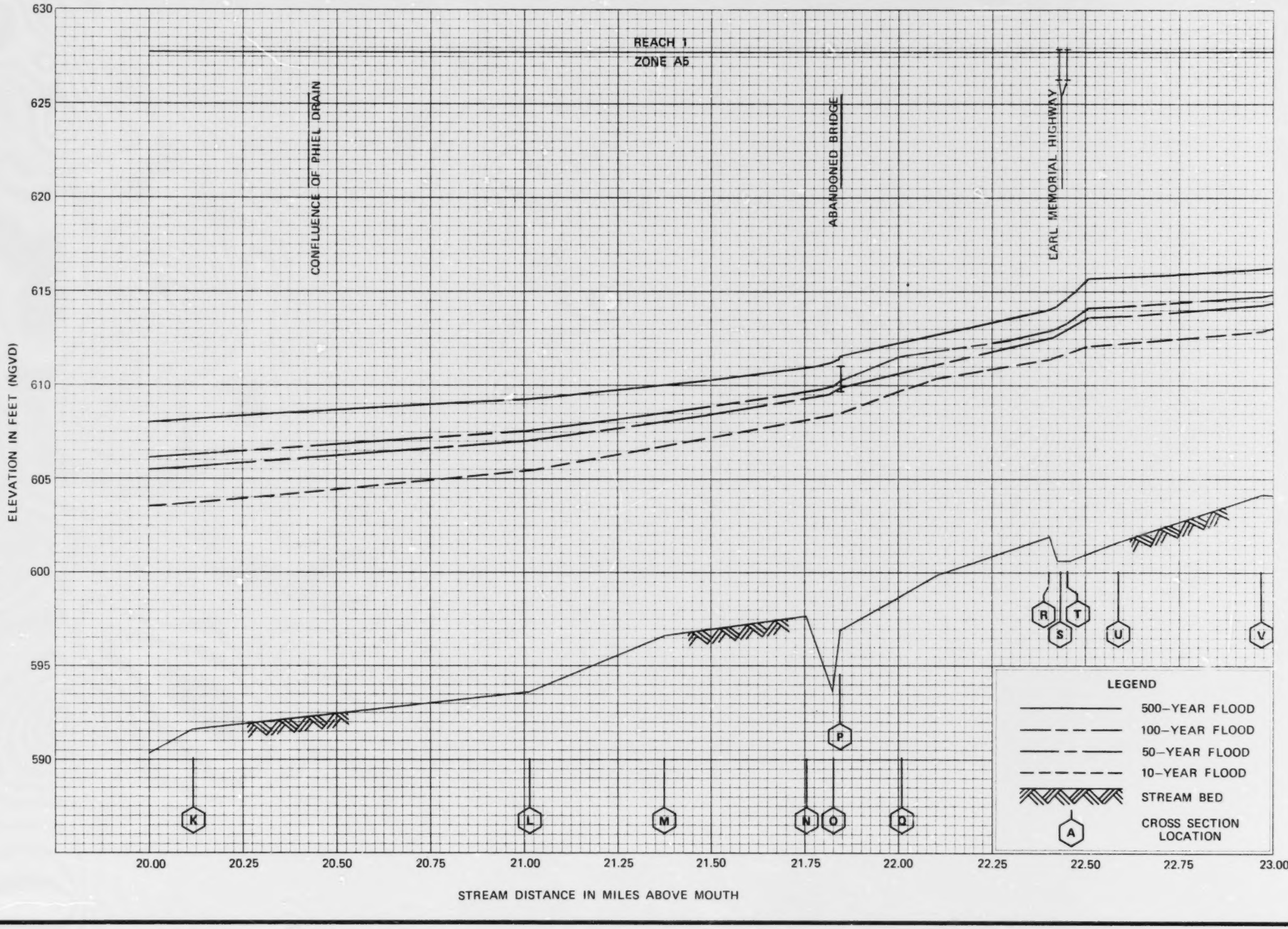
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

01P

REVISED: 5/15/86

BEST COPY AVAILABLE



FLOOD PROFILES

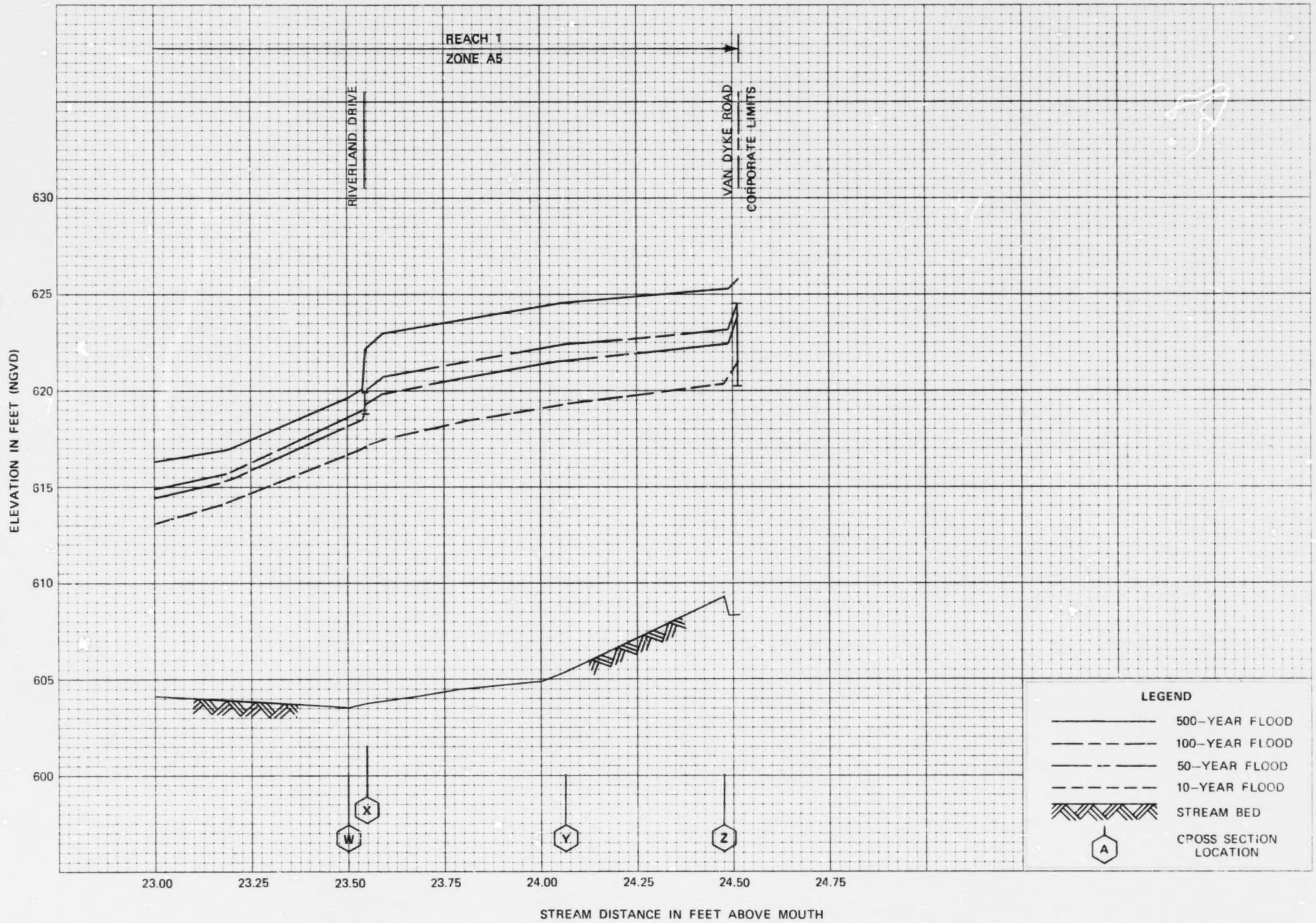
CLINTON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

02P

BEST COPY AVAILABLE



FLOOD PROFILES

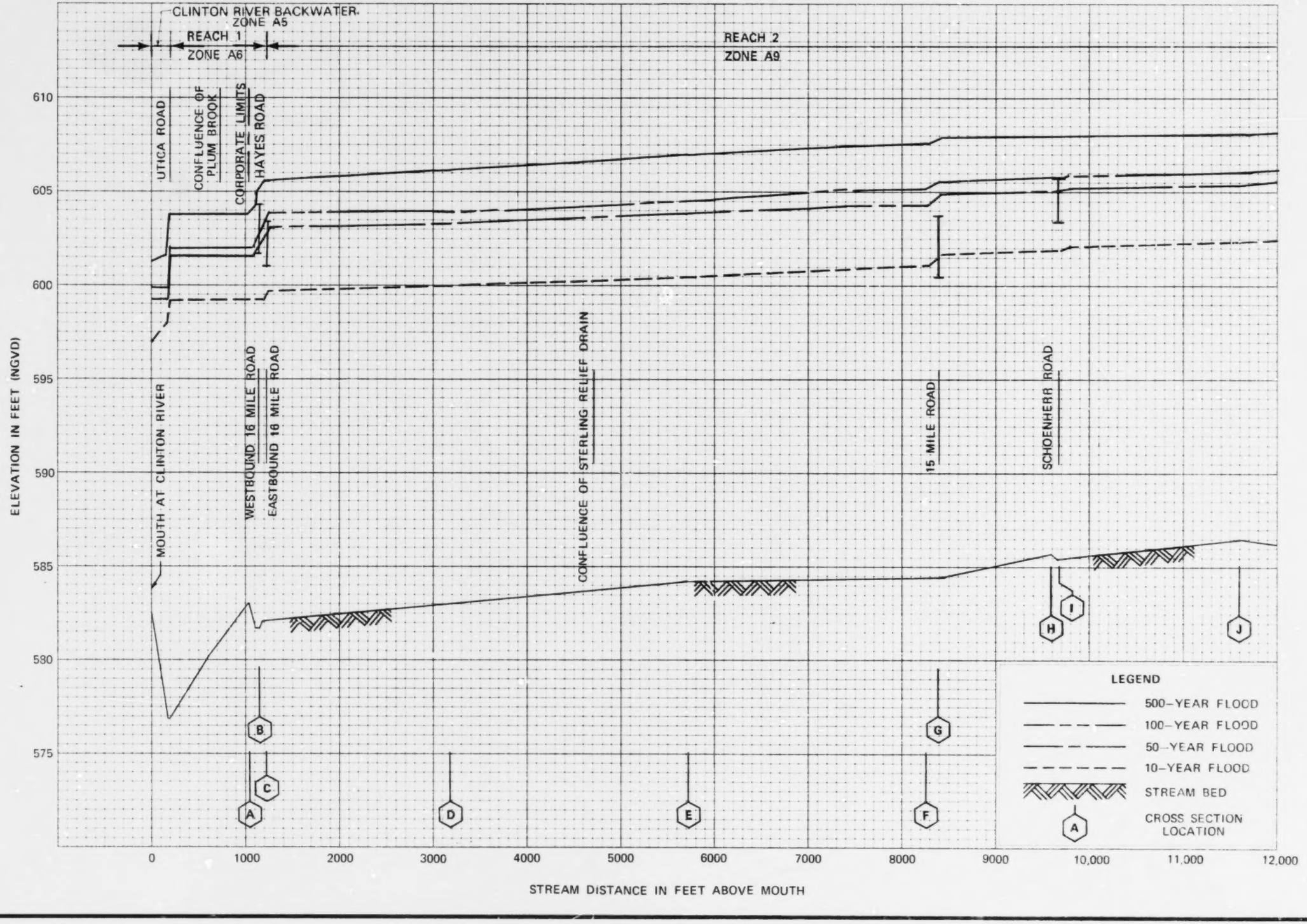
CLINTON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

03P

BEST COPY AVAILABLE



FLOOD PROFILES

RED RUN DRAIN

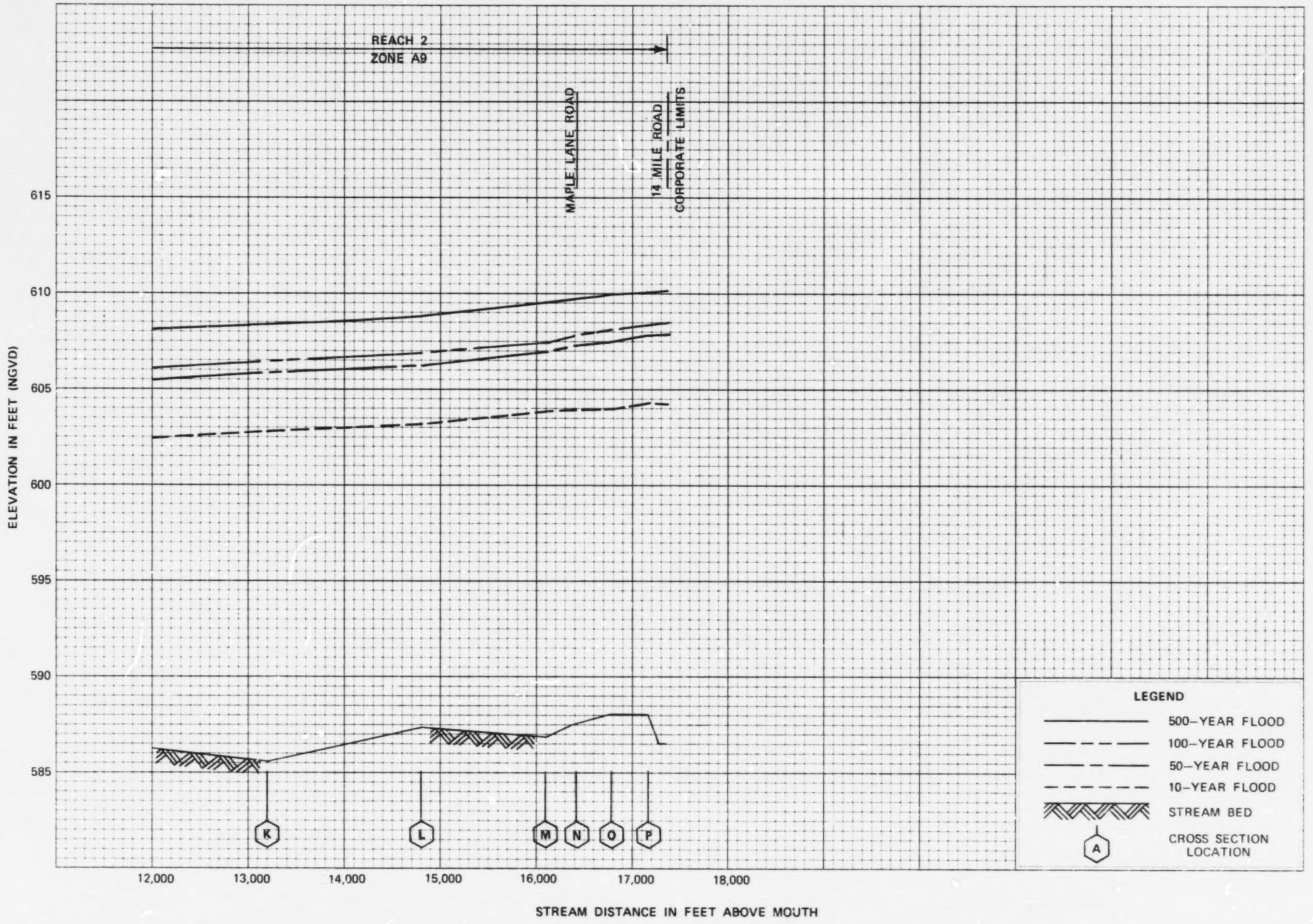
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

04P

REVISED: 5-15-86

BEST COPY AVAILABLE



FLOOD PROFILES

RED RUN DRAIN

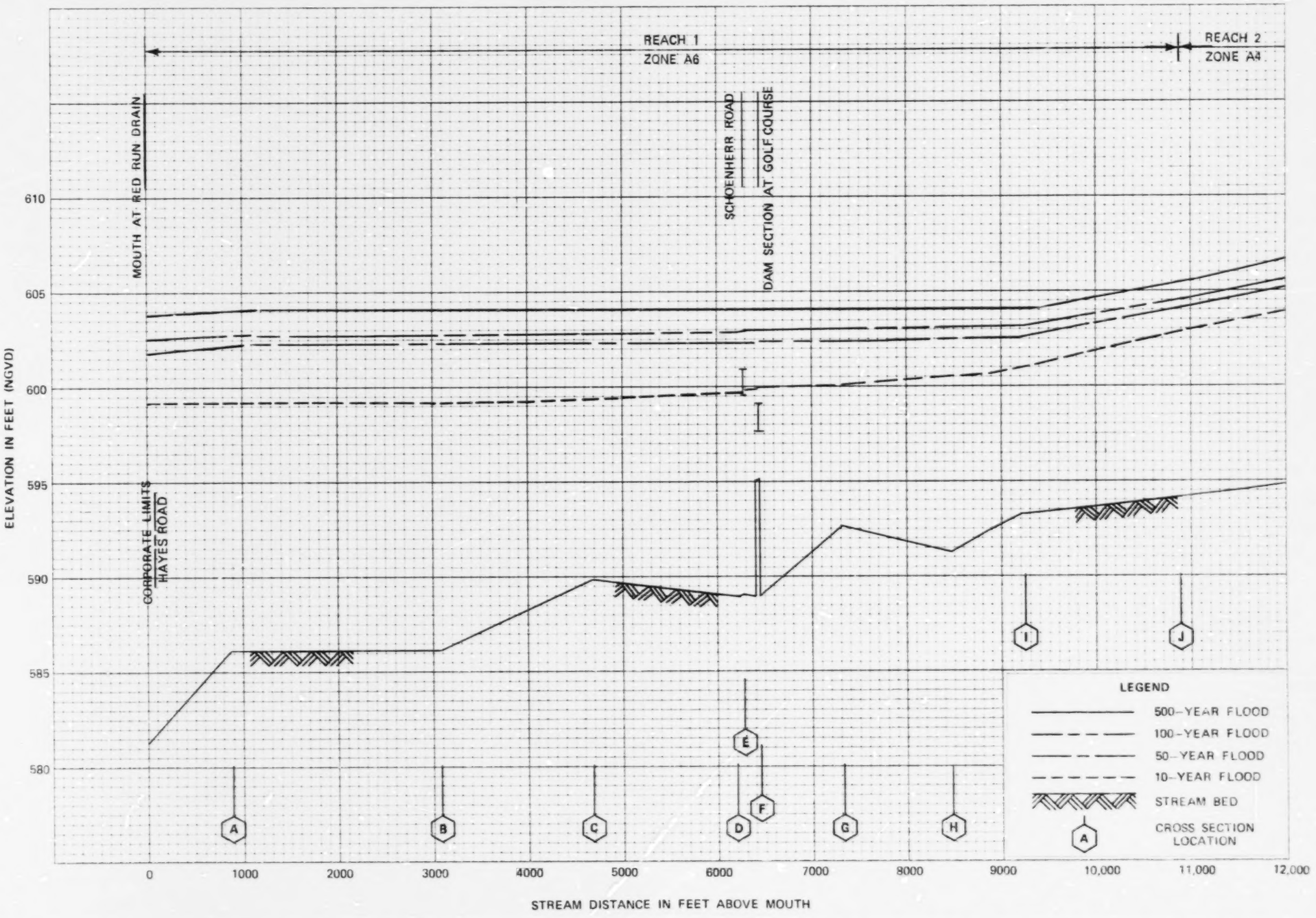
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

05P

REVISED: 5-15-86

BEST COPY AVAILABLE



FLOOD PROFILES

PLUM BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

06P

REVISED: 5-15-86

BEST COPY AVAILABLE

REACH 2
ZONE A4

DODGE PARK ROAD
VAN DYKE ROAD
GOLF COURSE CULVERT
CONRAIL

ELEVATION IN FEET (NGVD)

625
620
615
610
605
600
595
590

12,000 13,000 14,000 15,000 16,000 17,000 18,000 19,000 20,000 21,000 22,000 23,000 24,000

STREAM DISTANCE IN FEET ABOVE MOUTH

K L M N O P Q R S T U V W

LEGEND

500–YEAR FLOOD
100–YEAR FLOOD
50–YEAR FLOOD
10–YEAR FLOOD
STREAM BED
A — CROSS SECTION LOCATION

FLOOD PROFILES

PLUM BROOK

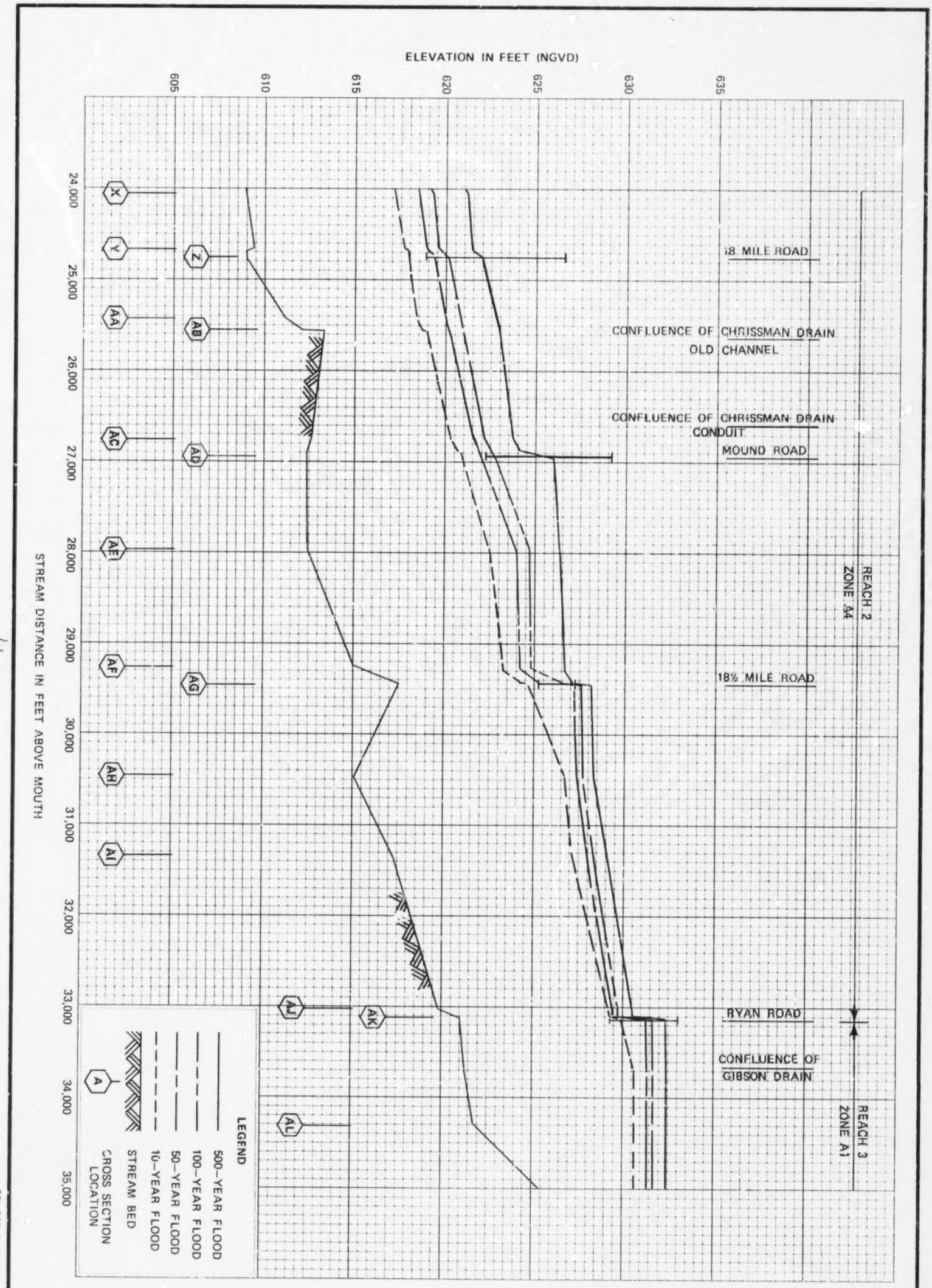
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

07P

REVISED: 5-15-86

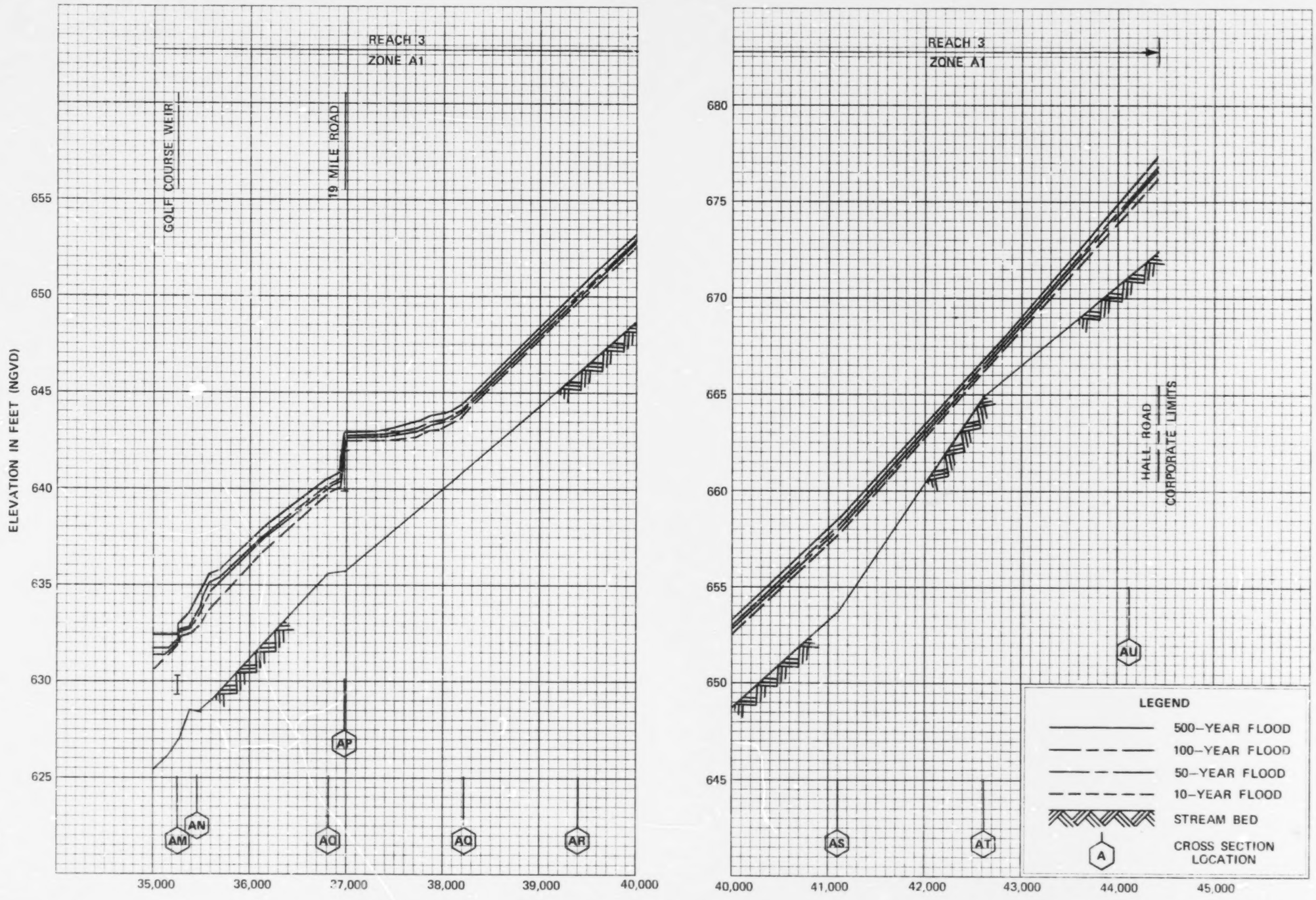
BEST COPY AVAILABLE



08P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF STERLING HEIGHTS, MI** (MACOMB CO.)	**FLOOD PROFILES** **PLUM BROOK**

REVISED 5-15-86

BEST COPY AVAILABLE



FLOOD PROFILES

PLUM BROOK

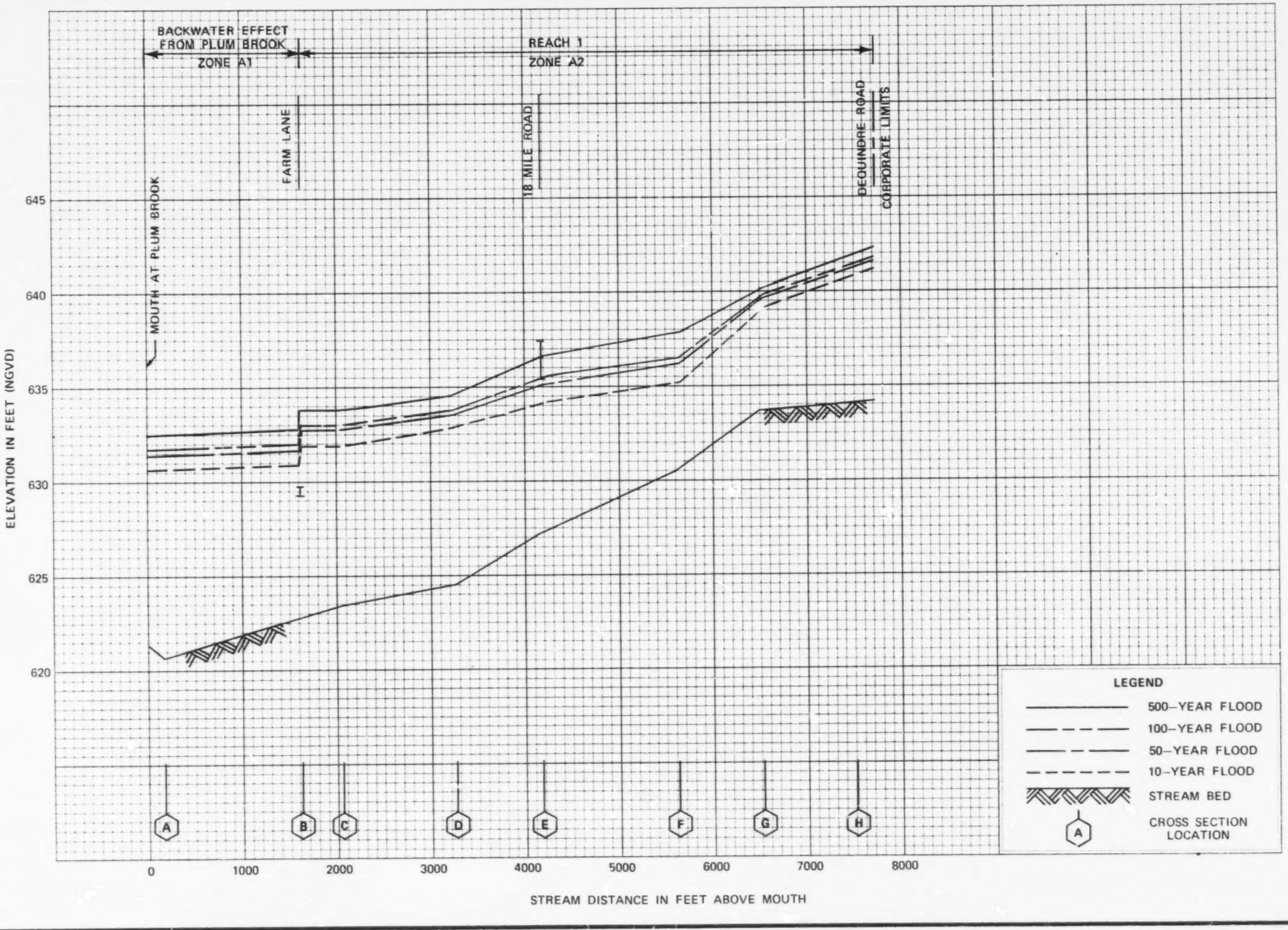
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

09P

REVISED: 5/15/86

BEST COPY AVAILABLE



FLOOD PROFILES

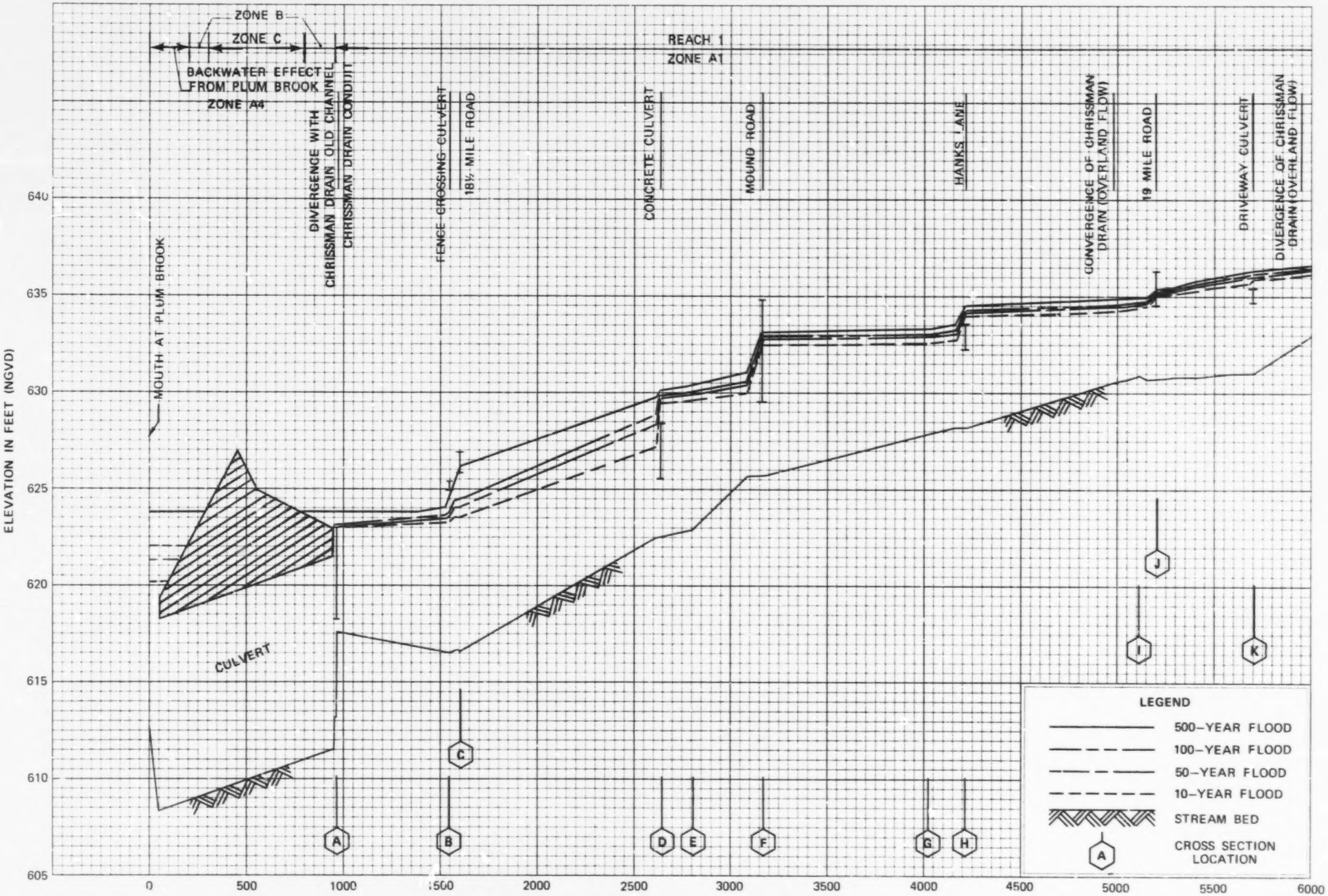
GIBSON DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

10P

BEST COPY AVAILABLE



FLOOD PROFILES

CHRISSMAN DRAIN

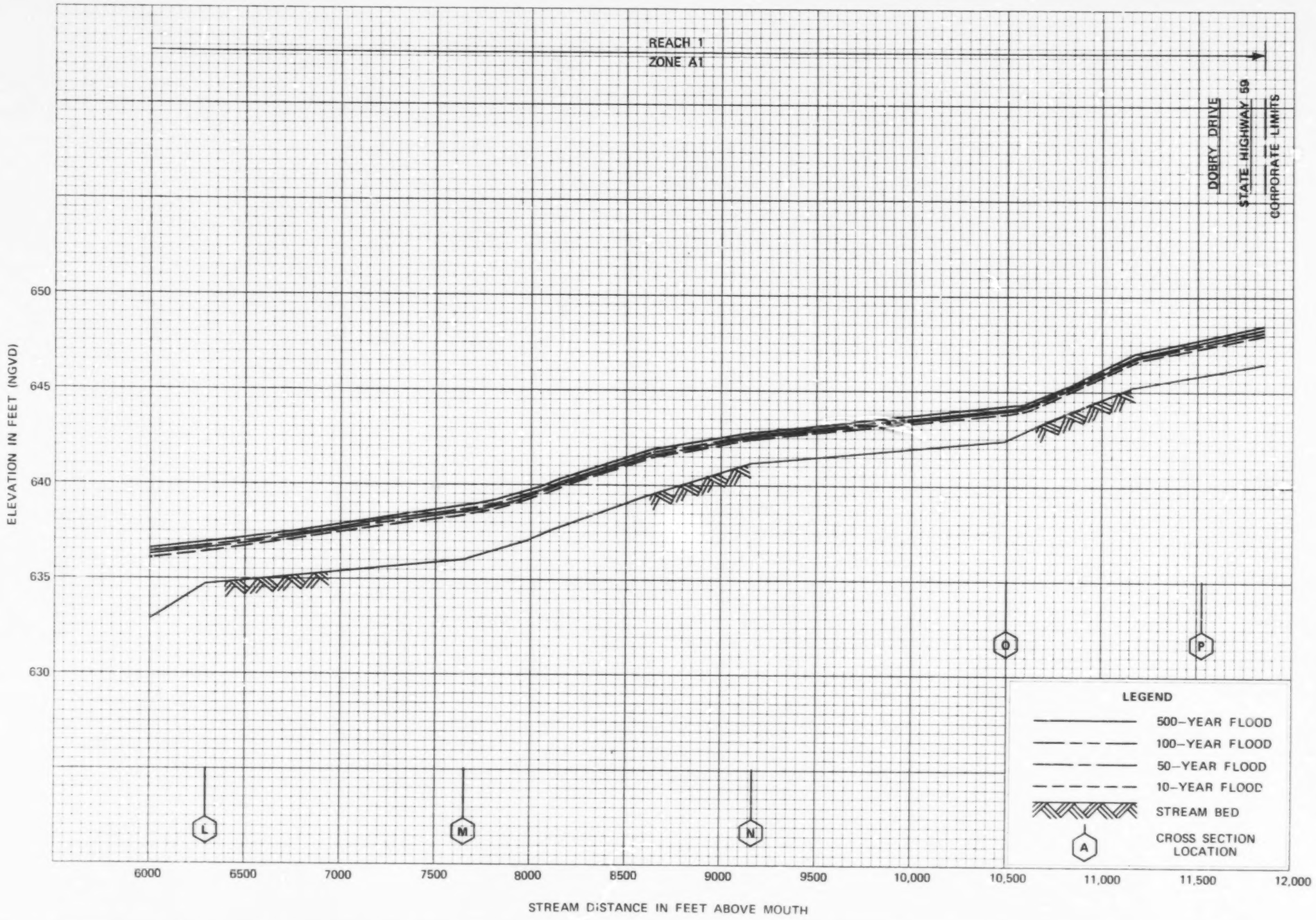
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI

(MACOMB CO.)

11P

BEST COPY AVAILABLE



FLOOD PROFILES

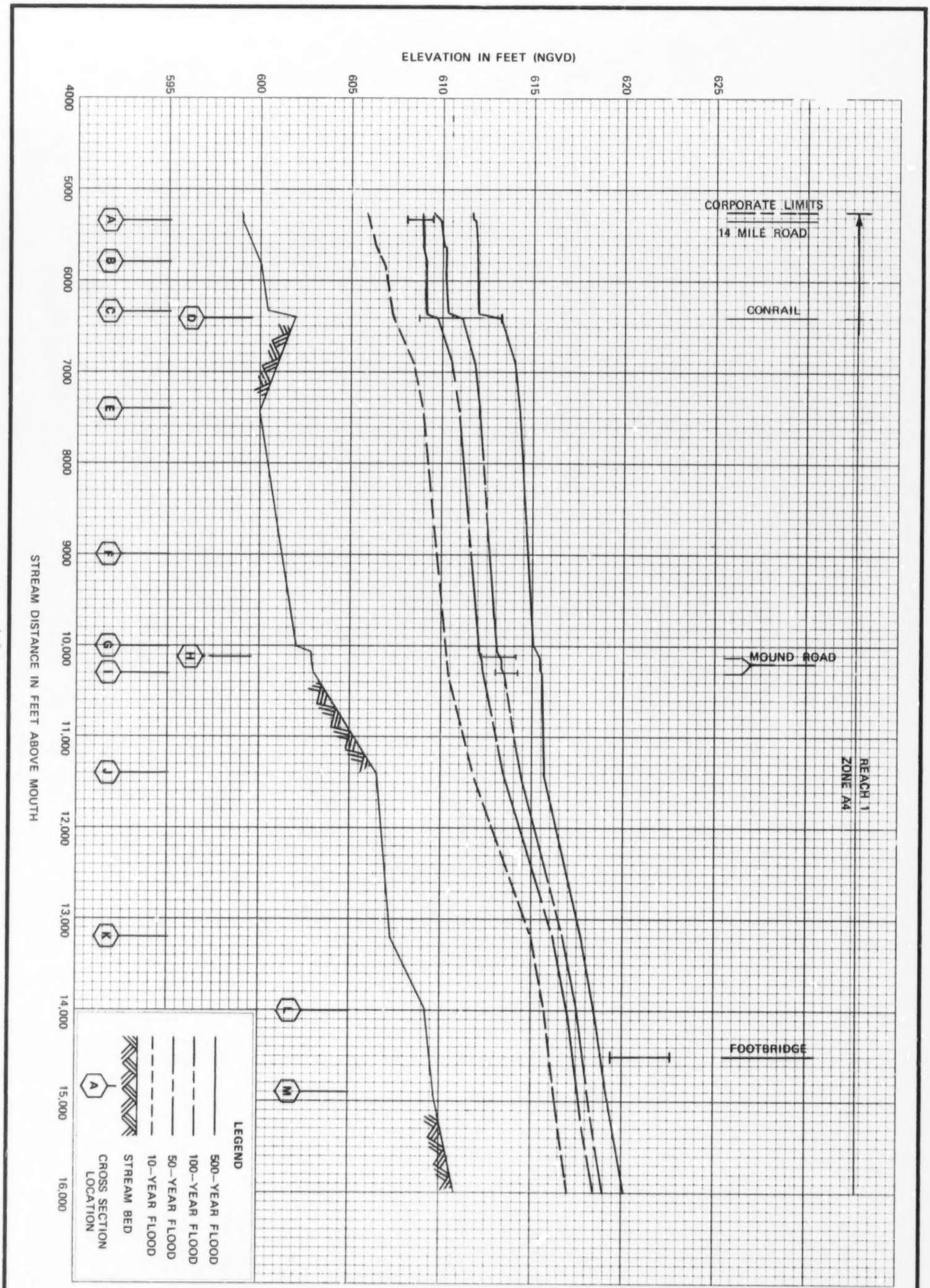
CHRISSMAN DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

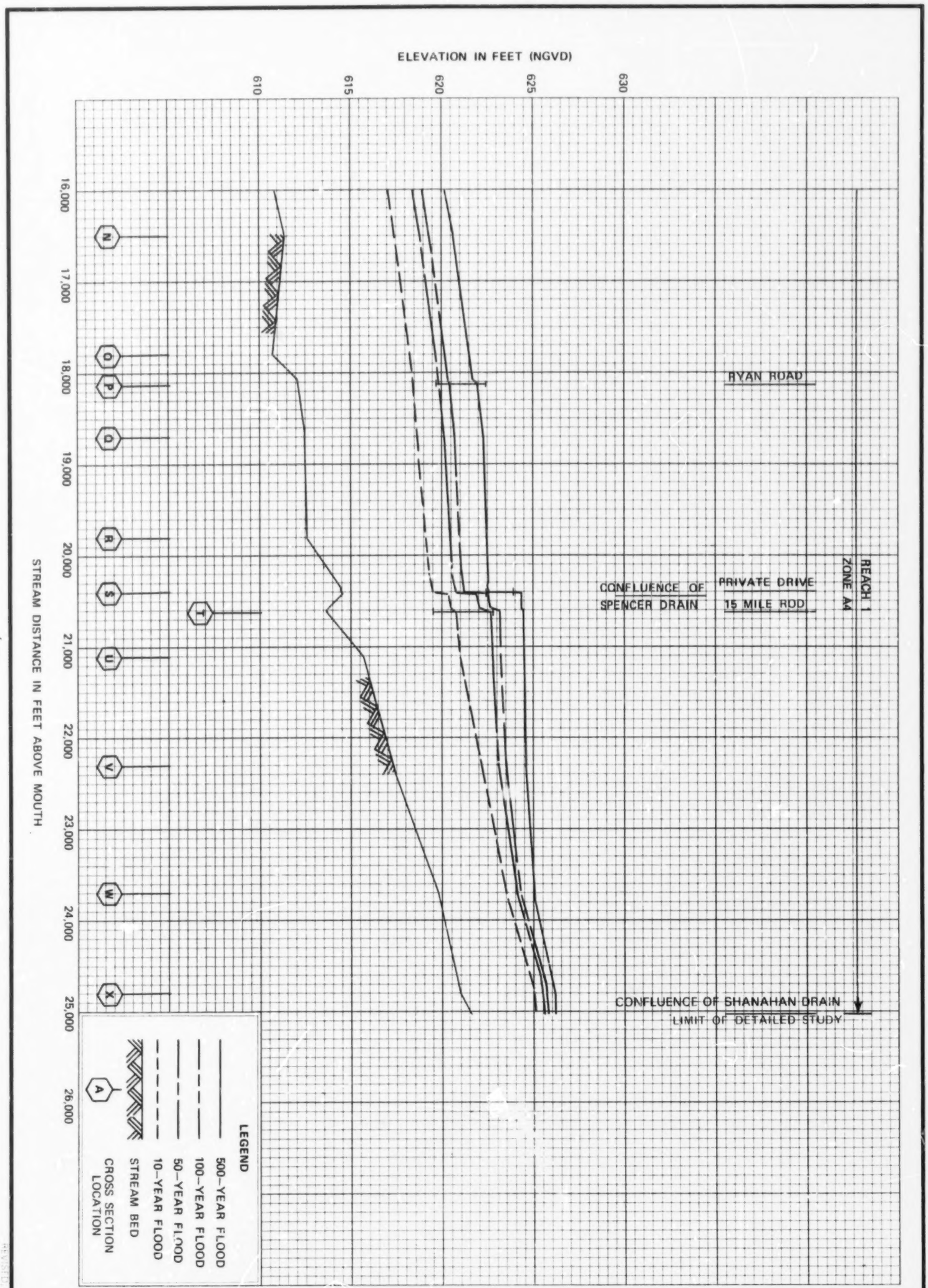
CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

12P

BEST COPY AVAILABLE



13P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF STERLING HEIGHTS, MI (MACOMB CO.)	FLOOD PROFILES BIG BEAVER CREEK



14P

FEDERAL EMERGENCY MANAGEMENT AGENCY

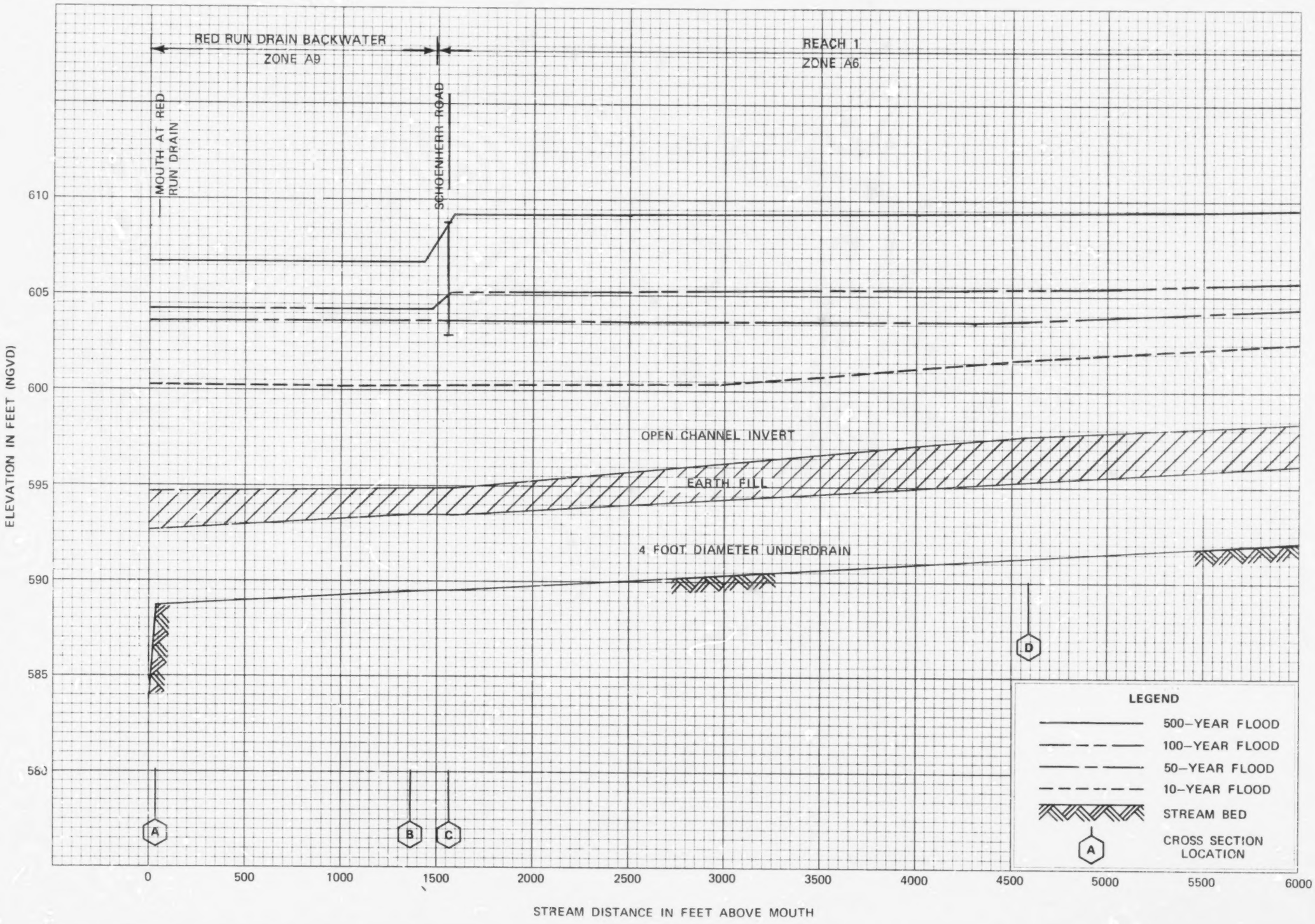
CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOOD PROFILES

BIG BEAVER CREEK

47

BEST COPY AVAILABLE



FLOOD PROFILES

STERLING RELIEF DRAIN

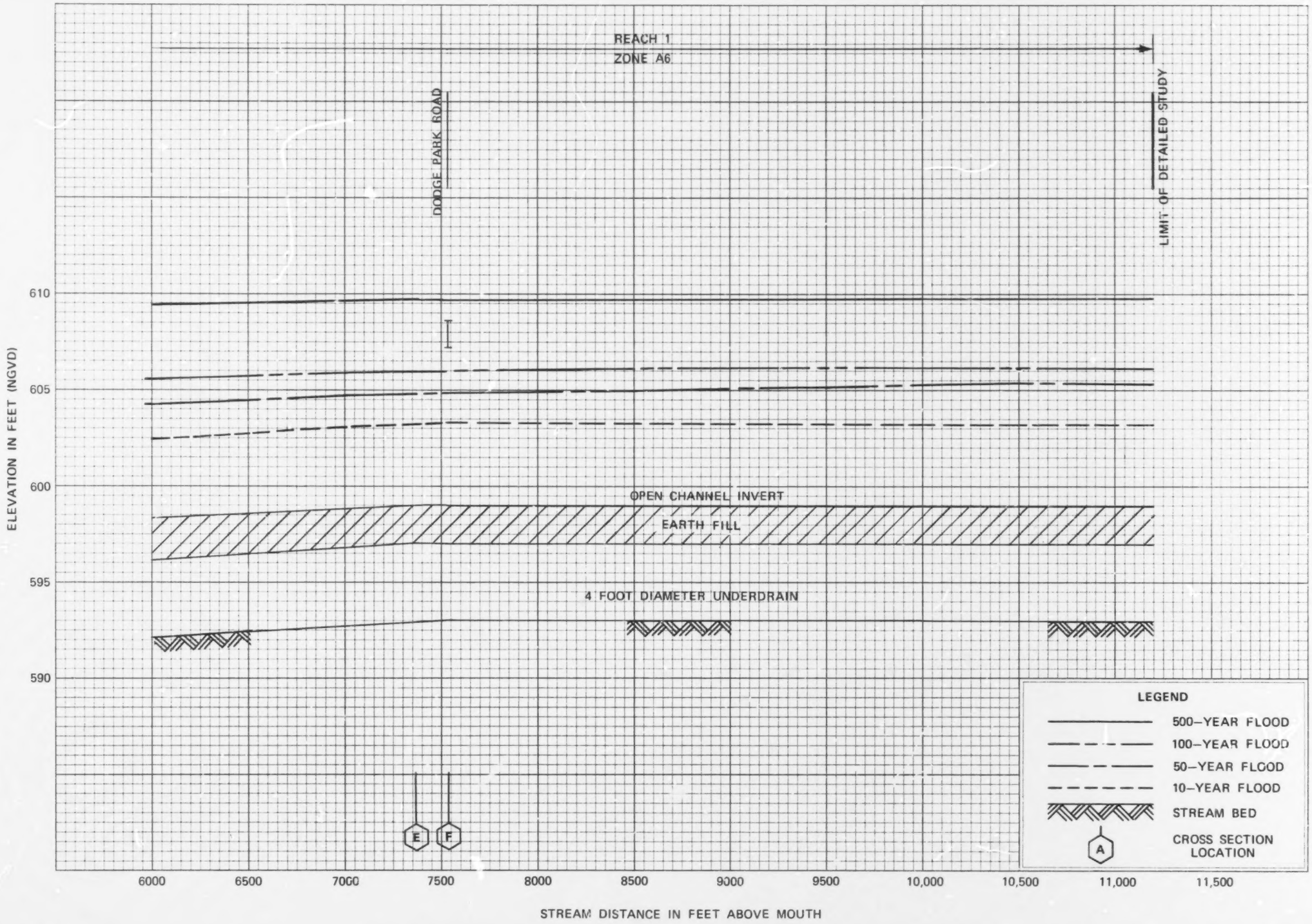
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

15P

REVISED: 5/15/86

BEST COPY AVAILABLE



FLOOD PROFILES

STERLING RELIEF DRAIN

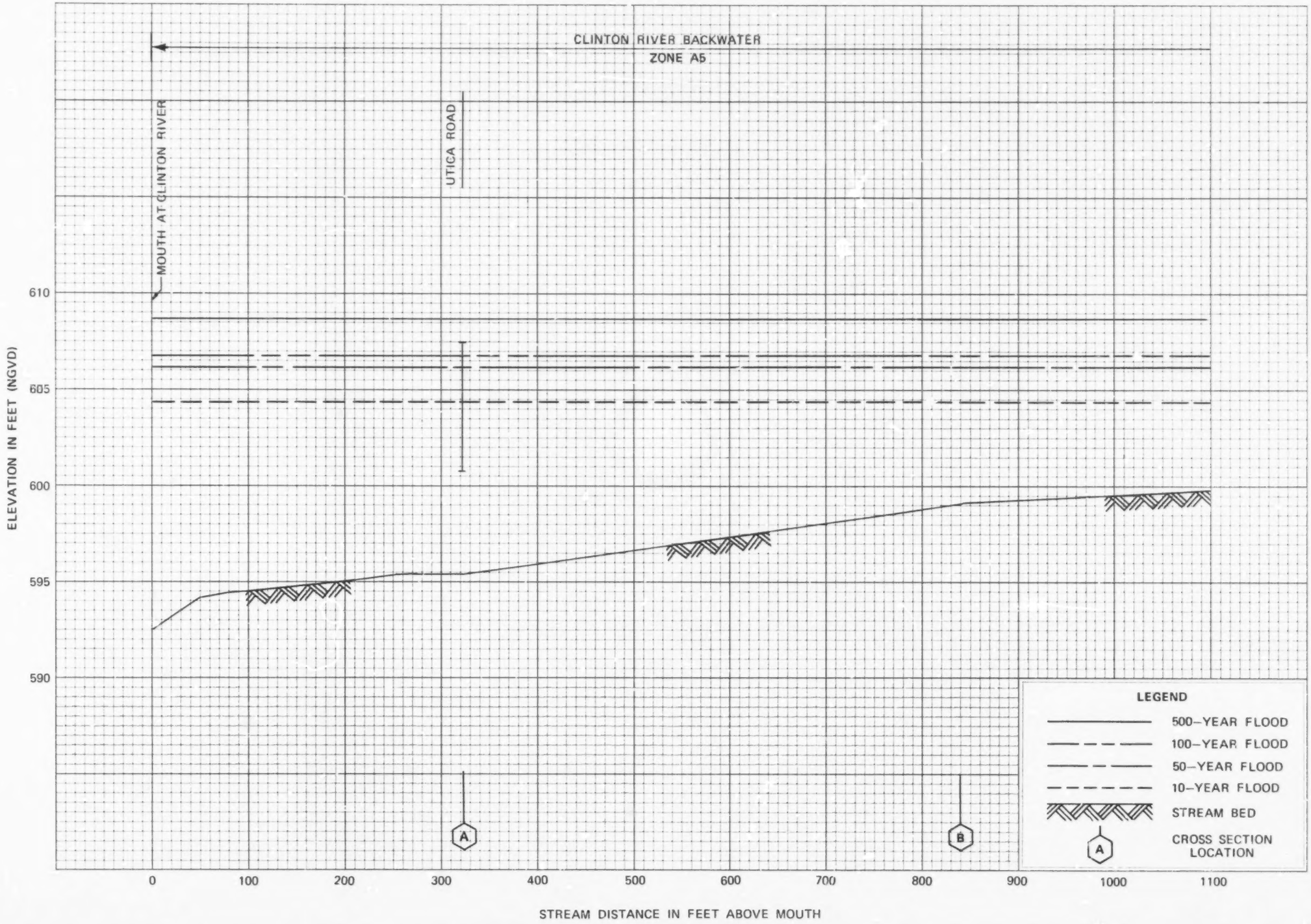
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

16P

REVISED: 5/15/86

BEST COPY AVAILABLE



FLOOD PROFILES

PHIEL DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

17P

BEST COPY AVAILABLE

REACH 1
ZONE A4

CLINTON RIVER BACKWATER
ZONE A5

DODGE PARK ROAD
LIMIT OF DETAILED STUDY

ELEVATION IN FEET (NGVD)

610
605
600
595

1100 1200 1300 1400 1500 1600 1700

STREAM DISTANCE IN FEET ABOVE MOUTH

C

LEGEND

- 500–YEAR FLOOD
- 100–YEAR FLOOD
- 50–YEAR FLOOD
- 10–YEAR FLOOD
- STREAM BED
- A — CROSS SECTION LOCATION

FLOOD PROFILES

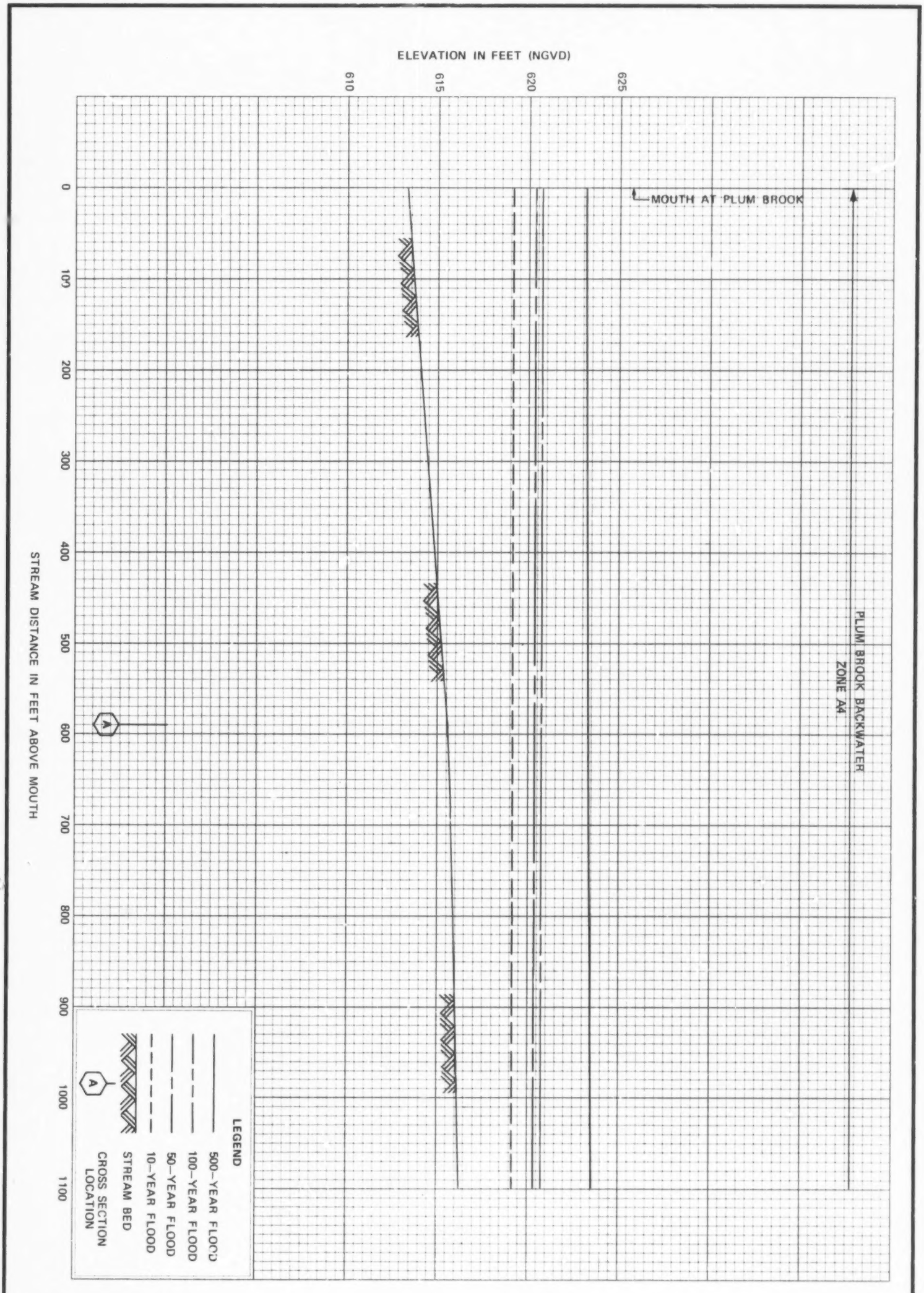
PHIEL DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

18P

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

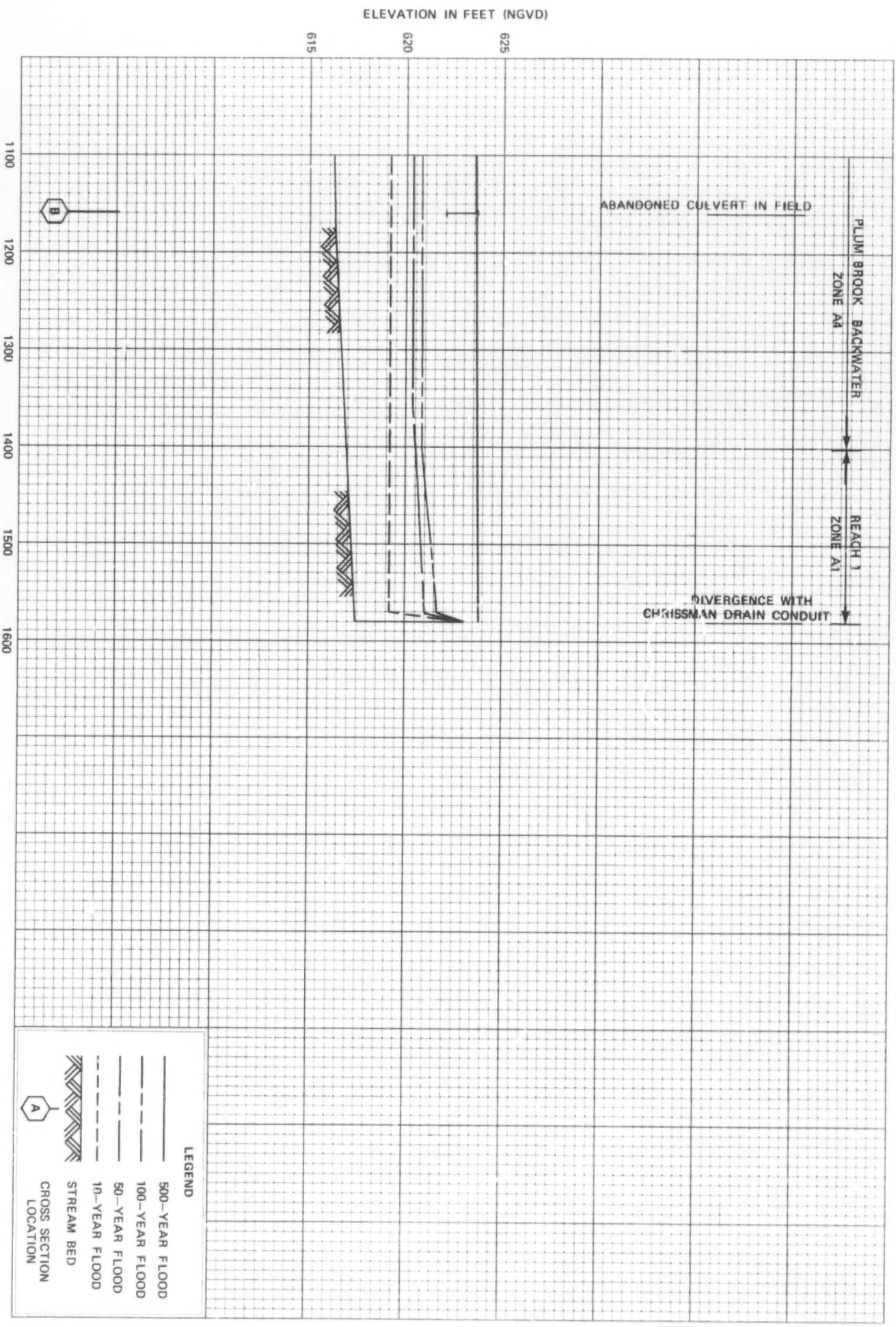
CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

FLOOD PROFILES

CHRISSMAN DRAIN (OLD CHANNEL)

19P

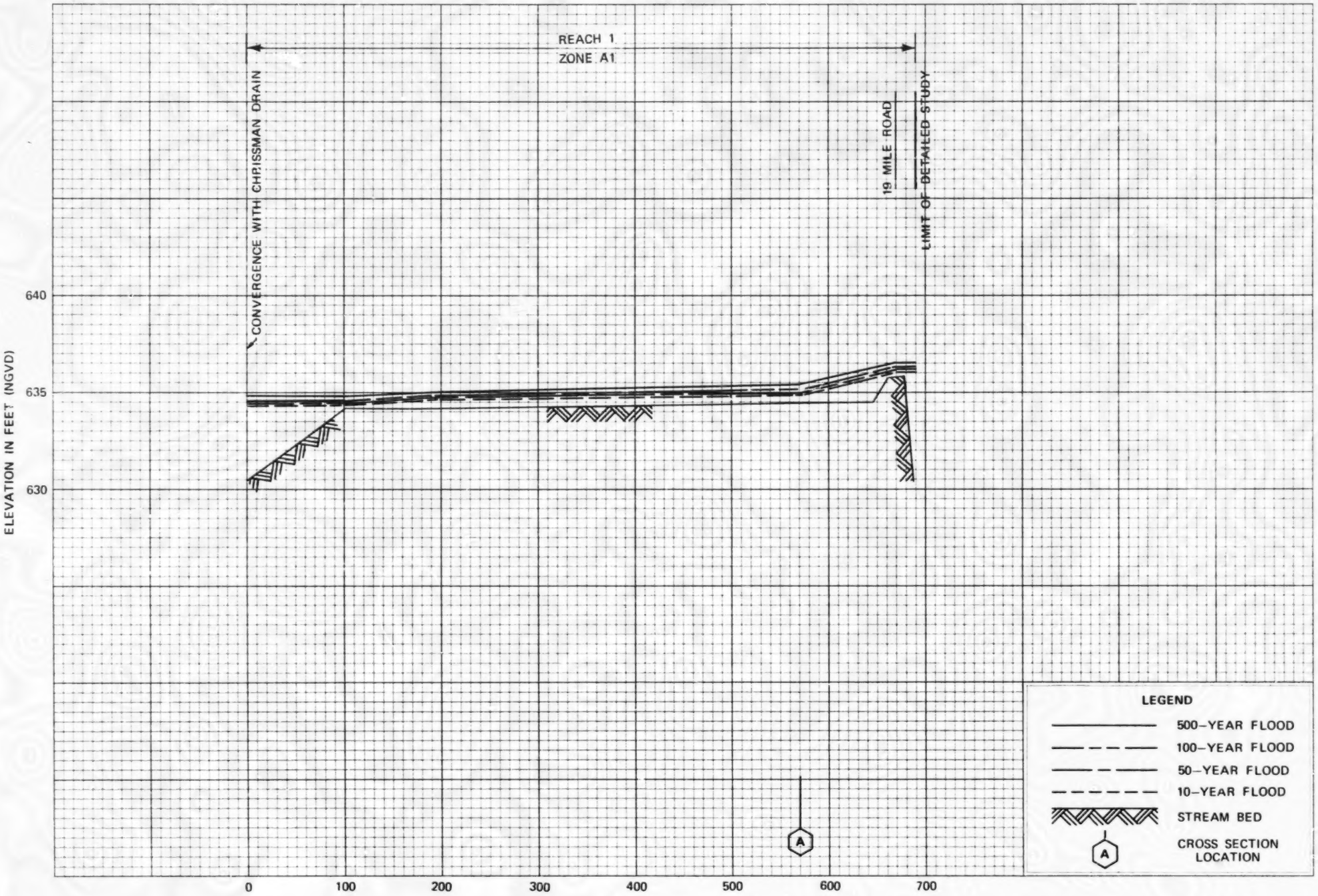
BEST COPY AVAILABLE



53

BEST COPY AVAILABLE

20P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF STERLING HEIGHTS, MI (MACOMB CO.)	FLOOD PROFILES CHRISSMAN DRAIN (OLD CHANNEL)



FLOOD PROFILES

CHRISSMAN DRAIN (OVERLAND FLOW)

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF STERLING HEIGHTS, MI
(MACOMB CO.)

21P

BEST COPY AVAILABLE